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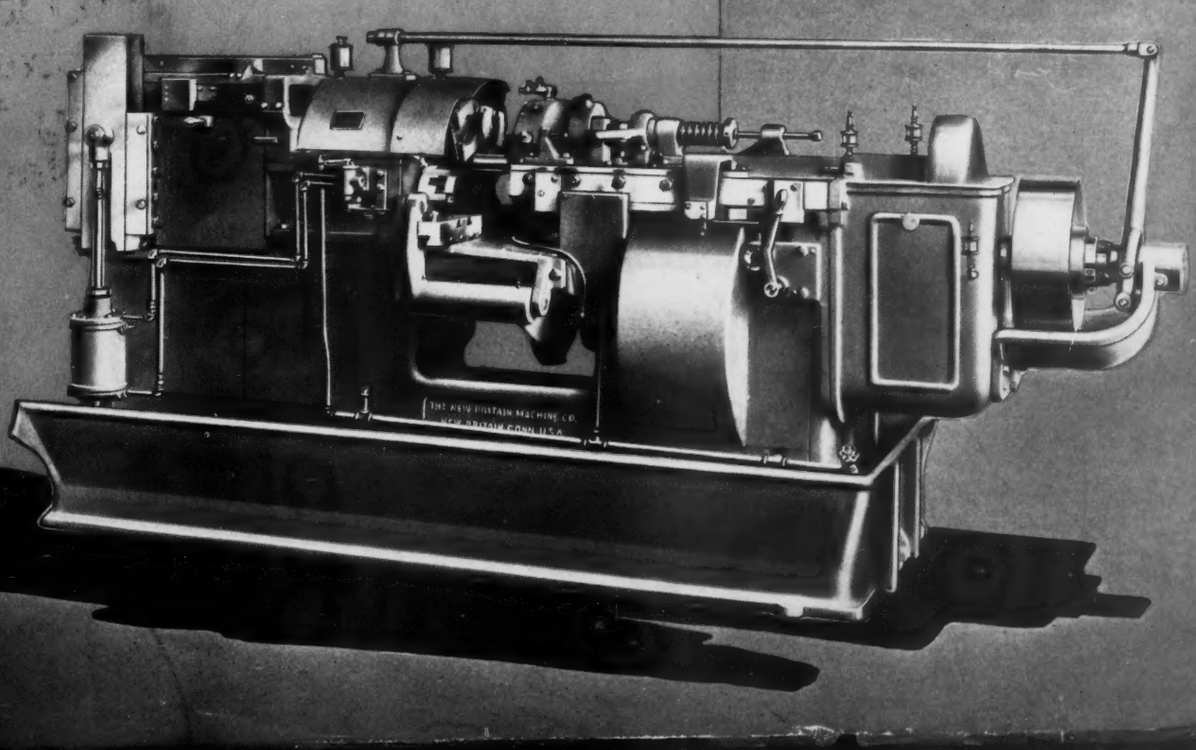

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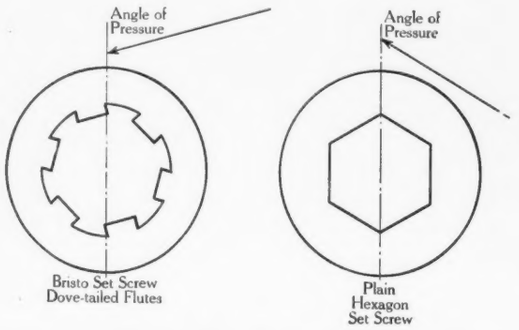

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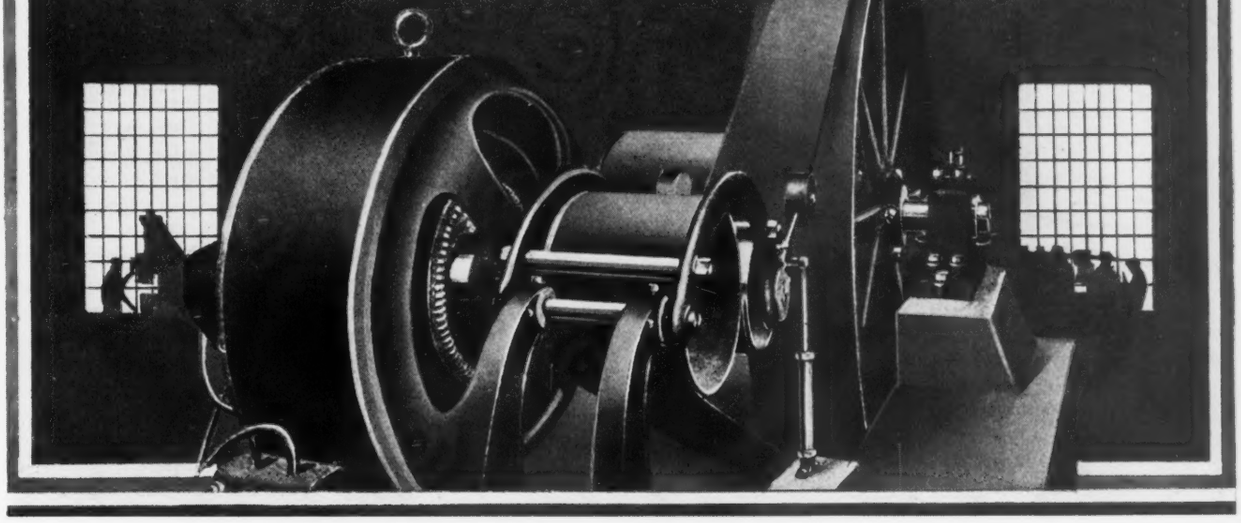
Short-center Belt Drives



General Characteristics, Advantages, and Methods of Arrangement to Meet Different Requirements—First of Three Articles

By GUSTAVE A. FRENKEL

BELT driving at short centers is comparatively little known to mechanical engineers, and in designing belt drives they adhere to the theories set forth in textbooks. These theories and the common rules of practice are not sufficient to meet successfully the varied requirements of an economical short-center drive, so that very often the designing engineer is confronted with difficulties which he is unable to overcome. There are a number of rules for common belt drives which have been complied with, as they are generally considered essential to satisfactory results. Several of the more common rules follow:

Vertical belt drives should be avoided, as sufficient adhesion of the belt on the lower pulley cannot be obtained.

The pulley centers should be at least 12 feet apart, and a horizontal drive is preferable.

The ratio of the pulley diameters should be less than 6 to 1.

The value used for the coefficient of friction should not be higher than 0.25, 0.10 being a fair average.

Idlers must be avoided.

The tight side of the belt should be at the bottom.

The ratio of the stresses in the slack and tight sides, under normal conditions, should be taken as 1 to 2, which means that the total belt pull producing bearing pressure amounts to three times the turning or tangential force.

None of these rules holds good for a modern short-center belt drive. It makes no difference whether the drive is vertical or horizontal, or whether the tight side of the belt is on the top or on the bottom. The center distance may be reduced any amount, provided there is the necessary clearance space between the pulleys. A modern short-center drive requires no more floor space than would be needed for a direct-connected geared or chain drive. The ratio of the pulley diameters may be as high as 1 to 20, and the "initial tension," which represents a loss, is eliminated almost entirely; consequently the ratio of the stresses in the slack and tight sides is reduced in some cases to 1 to 10, and even greater reductions are possible. As a result of the elimination of "initial tension," belts used in connection with short-center drives are from 38 to 60 per cent lighter than belts required to transmit the same power with open belt drives.

This article is the first of a series dealing with the efficient transmission of power by belting, as determined by numerous experiments and extensive research. The short-center type of drive will be dealt with exclusively, as the author has made a special study of such drives and has investigated thousands of installations, thus obtaining information and tabulated data which may be used readily in designing these belt drives in accordance with well established principles. Formulas for determining the power-transmitting capacities of short-center drives, and also for designing the important elements, are accompanied by examples illustrating their applications. The articles in this series constitute a valuable contribution to the important subject of power transmission by means of belting.

A short-center belt drive is an arrangement whereby a resilient tension roller (see Fig. 1) pivoted either concentric or eccentric to the axis of the smaller pulley (driving or driven) swings around this pulley, thus increasing or decreasing the arc of contact, depending on the increasing or decreasing of the load, and thereby maintaining the same stress in the slack side, regardless of the elongation of the belt. This belt drive was invented about 1900 by a French engineer-officer named Leneveu, and its efficiency has been proved by the installation of many thousands of drives in France. But the credit for developing the short-center belt drive in a scientific

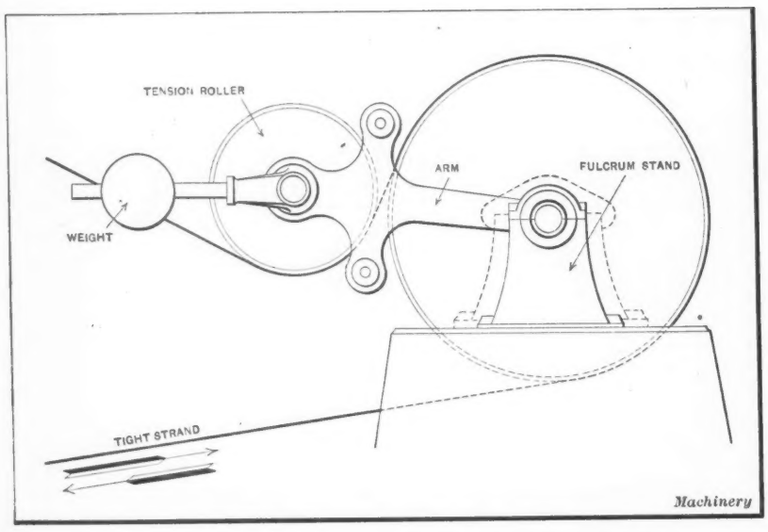


Fig. 1. Arrangement of Tension Roller for Short-center Belt Drive

way, undoubtedly belongs to the Berlin-Anhaltische Maschinenbau A. G., in Dessau, Germany, through whose efforts the drive has become well known under the name of "Lenix."

The following comparison of an open drive with a Lenix type illustrates in a general way the merits of the latter: In one installation, an open belt drive and a Lenix type are operated under the same conditions, each driving a 100-horsepower generator, both machines being alike. The open drive requires a 24-inch single leather belt, ¼ inch thick, whereas with a short-center drive the same power is transmitted by a 10-inch single leather belt of the same thickness. Notwithstanding the area reduction of approximately 60 per cent for the short-center drive, the total stresses in this belt are considerably less than in the open belt; naturally the bearing pressure is reduced accordingly.

A good leather belt, within a reasonable range of velocities, can be made to transmit almost any amount of power desired, up to the limit of its strength, by increasing the tension. High belt tensions, however, mean high bearing and journal pressures, resulting in a loss of power through increased friction. This also means short life for belts and high repair charges for bearings, not counting the waste of lubricating oils.

Advantages of Short-center Belt Drives

The advantages of a short-center belt drive over an open belt drive are best shown by the results of tests made with both drives operating under the same conditions. The duration of a certain test was six hours, and the load gradually increased from 10 to 100 horsepower. Both belts were running at 4240 feet per minute. Diagram *A*, Fig. 2, shows the open drive as tested. The prime mover was a 100-horsepower gas engine running at 225 revolutions per minute with a 72-inch diameter flywheel-pulley, driving a generator at 900 revolutions per minute with an 18-inch diameter pulley. The short-center drive as tested is shown at *B*. Under no load, the arc of contact of the belt was 232 degrees on the generator pulley and 241 degrees on the engine pulley. The arc of contact of the open belt on the generator pulley was 170 degrees. An increase of the arc of contact of the belt on the open drive, by increasing the load, was not noticeable, but the arcs of the short-center drive increased in proportion to the load applied, reaching their maximum of 248 degrees when the belt was running under its full load. The following data show the results:

	Open Drive	Short-center Drive
Horsepower transmitted	100	100
Belt velocity, feet per minute	4240	4240
Tangential force	778 pounds	778 pounds
Tension, tight side	1360 pounds	908 pounds
Tension, slack side	582 pounds	130 pounds
Friction losses in bearings:		
Engine bearing	1.148 H.P.	1.132 H.P.
Generator bearing	2.483 H.P.	0.489 H.P.
Tension roller		0.065 H.P.
Total friction loss	3.631 H.P.	1.686 H.P.
Bending loss in belt	0.043 H.P.	0.025 H.P.
Loss through belt slip	4.10 H.P.	0.20 H.P.
Total loss	7.774 H.P.	1.911 H.P.
Size of belt	18"x⅜"x48'	16"x$\frac{3}{16}$"x27½'
Bearing pressure due to belt pull	2100 pounds	965 pounds

These results, expressed in percentages, are: Reduction of bearing pressure due to belt pull, 54 per cent; reduction of friction losses, 53.6 per cent; reduction of bending losses, 42 per cent; reduction of belt slip, 95 per cent; total reduction of losses, 75 per cent; reduction of cross-sectional belt area, 55 per cent; reduction of belt length, 43 per cent.

The slippage which occurred at the different stages of the test is indicated on the chart Fig. 3. This shows that for the open drive in the earlier stage of the test, the increase in slippage was about 0.1 per cent for each additional 5 horsepower; then the slippage increased rapidly with the increased load, amounting to more than 0.5 per cent for each additional 5 horsepower when the belt was approaching full load, the total slippage at full load being 4.1 per cent. No increase of apparent slippage occurred on the short-center drive, the line indicating the slippage of the belt curving slightly downward at the approach to full load. The reason for this phenomenon will be explained later.

During the test a careful investigation of the temperature of the generator bearings was made at regular intervals. The chart Fig. 5 illustrates the excessive heating of the well lubricated bearings of the open belt drive. At the end

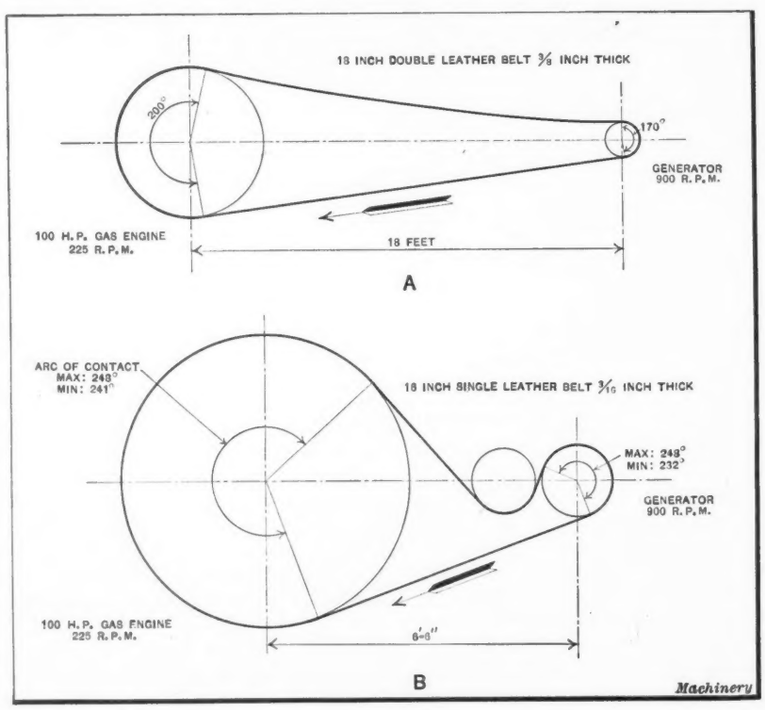


Fig. 2. Diagrams representing Open Belt Drive (A) and Short-center Belt Drive (B) operating under the Same Conditions

of the six-hour test the temperature of the generator bearings on the open belt drive was 156 degrees F. The pressure on these bearings was about 194 pounds per square inch. The temperature of the bearings on the short-center belt drive was 131.5 degrees F., and the pressure only 93 pounds per square inch.

To demonstrate the superior features of a short-center belt drive, the apparatus shown in Fig. 4 has been used. This apparatus shows clearly how the stresses in the belt, the pressure on the bearings, etc., are greatly reduced in a well designed short-center drive, as compared with a common open belt drive. With an equal power-transmitting capacity, measured by the weights *B* of the brakes, the belt *A* of the open drive has to be stressed with the weight *D*, while the short belt *C* does the same work under a stress resulting from the small weight *E*.

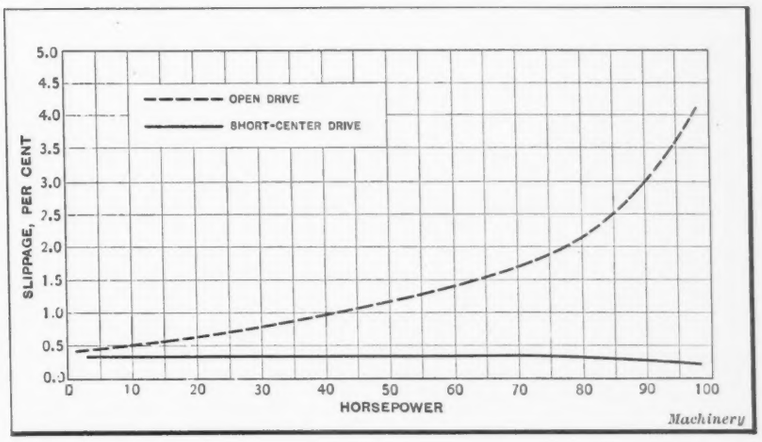


Fig. 3. Chart showing Slippage of Open Belt Drive as compared with a Short-center Drive

It is well known that an open belt drive will not maintain its working tension very long. This tension constantly decreases until it is impossible to transmit the desired horsepower. The original working tension must therefore be restored by shortening the belt. If this can be arranged for after working hours, the effect on production will be confined to loss through slippage. In many instances, slippage becomes so excessive that the man in charge of the belts is forced to use belt dressing, or, worse still, applies rosin to the belt in order to maintain the capacity of the machine. The belt thus will be ruined within a short time, as when subjected to this treatment, it will crack and finally break.

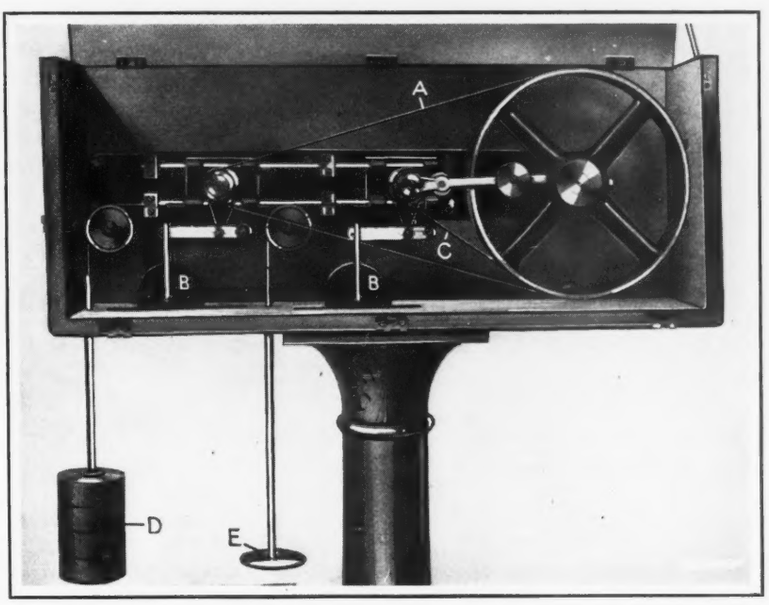


Fig. 4. Apparatus used to demonstrate Superiority of Short-center Belt Drive as compared with the Open Drive

A belt drive, however, is cheaper than gear or chain drives; the maintenance cost is low, provided the belt is properly cared for. Furthermore, a belt drive is simple in design, runs almost noiselessly, and possesses a certain amount of elasticity capable of absorbing shocks and vibrations. A modern short-center belt drive eliminates the shortcomings of an open belt drive, and combines the good features of other drives, such as gear, chain, worm, friction, and rope drives; in addition, it has other advantages that none of the foregoing drives possesses.

These properties make the use of the short-center belt drive almost unlimited. It is being used successfully, direct-connected at short centers, for driving lineshafts, jackshafts, generators, air compressors, centrifugal pumps, blowers and exhausters, conveyors, machine tools, etc. The short-center belt drive has replaced, in many instances, geared drives and chain-driven units. Considerable space has been saved in certain installations due to the high ratio made possible by the employment of the short-center belt drive; for example, in one case several gear reductions, with their various countershafts and bearings were taken out and the motor was set close to the machine for the belt drive, thus taking only one-eighth of the space formerly occupied.

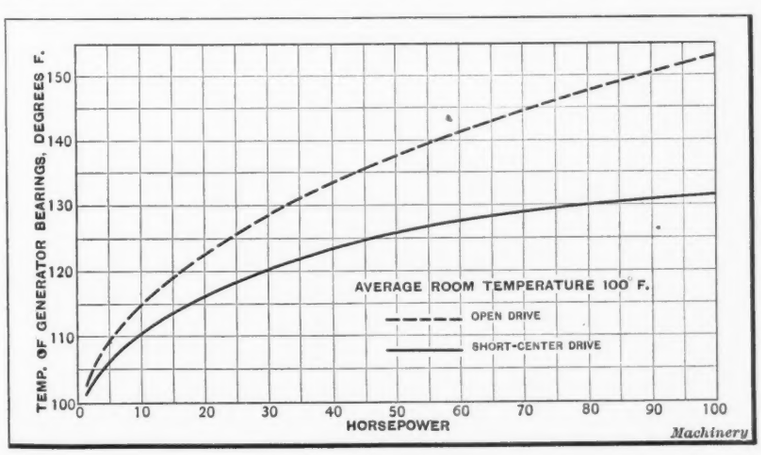


Fig. 5. Comparison of Open Drive and Short-center Drive on Basis of Bearing Temperatures

Since the introduction of the individual electric motor drive and the engine-driven high-speed generator, the designing engineer has been confronted continually with the problem of reducing from a high speed down to the speed desired. The short-center belt drive eliminates this difficulty. The high ratio attainable with the short-center belt drive permits connecting a high-speed motor directly by a short belt without further reductions. High-speed motors and generators mean not only lower first cost, but also higher efficiency, power factors and starting torque than can be obtained with lower-speed motors or generators. This is another important item in favor of short-center drives.

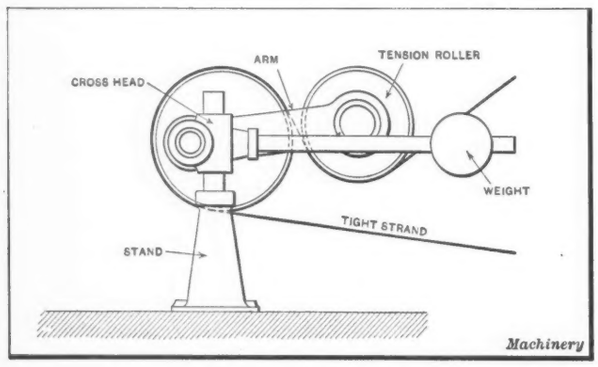


Fig. 6. Single-arm Support for Tension Roller

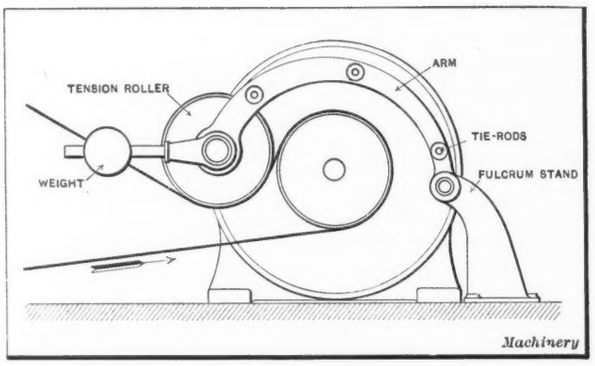


Fig. 7. Double-arm Overhung Support for Tension Roller

As regards the application of the short-center belt drive, it may be said that this drive can be employed whenever it is desired to connect a prime mover direct to a machine without resorting to reductions by countershafts, or, if a lineshaft is to be driven, to set the motor or engine close to the shaft. The relative location of the pulleys is immaterial. The pulley ratio is limited only by the relation between the thickness of the belt and the diameter of the smaller pulley; for example, if for some reason a large enough driven pulley cannot be placed on the machine, the smaller driving pulley diameter is limited by the thickness of the belt used. The short-center belt drive is adaptable to pulley rotation in either direction with the same efficiency. It is successfully used not only for steady loads but for heavily pulsating loads, as in driving compressors, ball mills, etc. The application of this drive is very broad and covers everything from light high-speed drives to very heavy power transmissions.

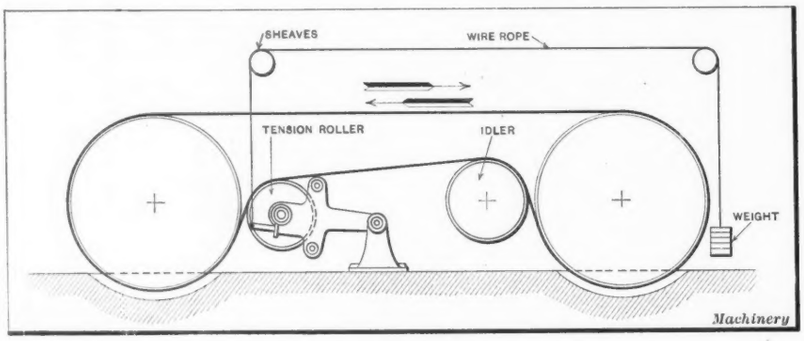


Fig. 8. Arrangement recommended for Very Slow Speeds, an Idler being used in Conjunction with a Tension Roller

If the belt is protected from oil, moisture, steam, or water, a good fulled leather belt should be used, but if the belt is exposed to dampness, the use of rubber belting is preferable. In some instances cotton belts are recommended, as these give excellent service, especially for outdoor work. If an ordinary open belt drive with long centers is not operating properly and it is not possible to reduce the distance between the centers of the pulleys, the application of a resilient tension roller equipment, without changing the centers, will greatly increase the power-transmitting capacity or permit of a light grade of belt being used where a heavy belt had formerly been employed. The power-transmitting capacity is increased about 50 per cent when a resilient tension roller is applied to an open belt drive without changing the size of the belt.

Different Arrangements of Short-center Belt Drives

When a motor or engine is equipped with an outboard bearing and there is ample space between the pulley and the bearings, or when the drive is a main drive from engine to lineshaft, where large pulleys are usually required, the concentric form of roller support (Fig. 1) is the best. With this design, the fulcrum may be held in line with the center of the driving pulley, by means of stands or brackets, or the fulcrum bearings may be formed by an extension cast on the main bearings. The arms that support the tension roller swing freely about the fulcrum, and the necessary tension in the belt is obtained by equalizing weights on levers extending from the tension roller arms. If the slack side of the belt is on the bottom, the tension roller is pressed against the belt by weight-carrying ropes passing over sheaves.

The single-arm support, Fig. 6, is especially adapted for lighter belts. It can be used with the slack side of the belt either on the top or on the bottom. The fulcrum stand is fitted with a cross-head, embodying a universal joint which allows a vertical and horizontal adjustment of the fulcrum. The lever carrying the equalizing weight is arranged in such a way that it can be reversed, making this style of short-center drive adaptable for almost any condition. Its ap-

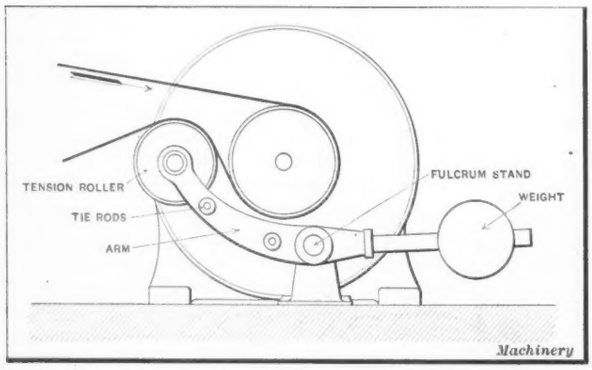


Fig. 9. Double-arm Underhung Type of Support for Tension Roller

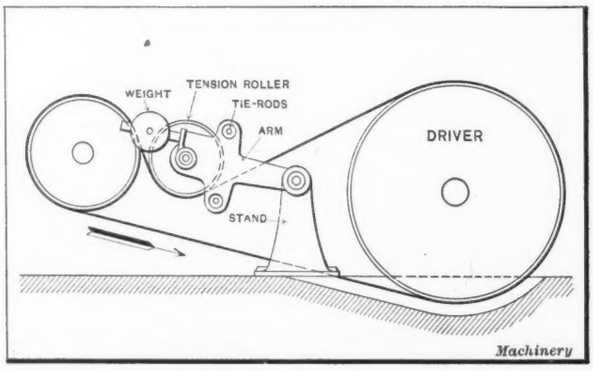


Fig. 10. Fulcrum Stand for Tension Roller placed between Pulleys

plication is especially recommended where there is little floor space.

The double-arm overhung support (Fig. 7) is the most commonly used type. It has two curved arms connected by tie-rods, and the fulcrum shaft and its stands are placed in front of the pulley. The equalizing weights slide on levers forming an extension of the arms. These weights are placed close to the tension roller when the short-center belt drive is installed, and then are moved outward gradually to the point where belt slippage is just prevented. Thereafter any load variation is compensated for automatically by the swinging movement of the tension roller, which takes up the elongation of the belt produced by the increased load. When part of the load is released, the free-swinging roller allows the contraction of the belt to its former length. This arrangement can also be used with the slack side of the belt on the bottom, by simply reversing the arms. In this case the tension roller is counterweighted by weights hanging on ropes running over sheaves. The double-arm overhung drive is suitable for all belt widths over 10 inches.

Very often the conditions of a building render it impracticable to place the equalizing weights on ropes; then the application of a double-arm underhung support (Fig. 9) is very convenient, the tension roller in this case being counterbalanced by movable weights on levers. This type has to be made very strong, owing to the stress on the fulcrum bearings. It can be used only with the slack side of the belt on the bottom, and is not recommended for belts over 20 inches wide, as the counterweights would be too large.

When the pulley speeds are comparatively low, and the pulley diameters must consequently be extremely large in order to obtain sufficient belt velocity, the use of a double-arm overhung support, as illustrated in Fig. 7, with the fulcrum in front of the pulley, is not practicable. Owing to the dimensions and the span of the arms, it would be difficult to obtain the necessary rigidity; besides, the weight of the parts would be far in excess of that required for tension in the slack side of the belt, making it necessary to counterbalance a portion of this dead weight.

In such cases, the proper solution is to place the tension roller equipment between the centers of the driving and driven pulleys and near the smaller one. Such an arrangement is shown in Fig. 10. The fulcrum may be located between the tight and slack strands of the belt, or on the outside, according to the relative location of the pulleys. Care must be taken to see that the tie-rods clear the belt within the working range of the tension roller. This position between the centers is especially adapted for heavy duty, and can be used either with the tight strand of the belt on the top or on the bottom.

For very slow-speed belt drives an idler near the opposite pulley is recommended, as illustrated in Fig. 8. This installation has been successfully operated with as low a speed as 12 revolutions per minute of the driven shaft, transmitting over 300 horsepower. If there is ample space on the shaft between the pulley and the adjacent bearings, the arrangement illustrated in Fig. 1 may also be employed successfully for low speeds.

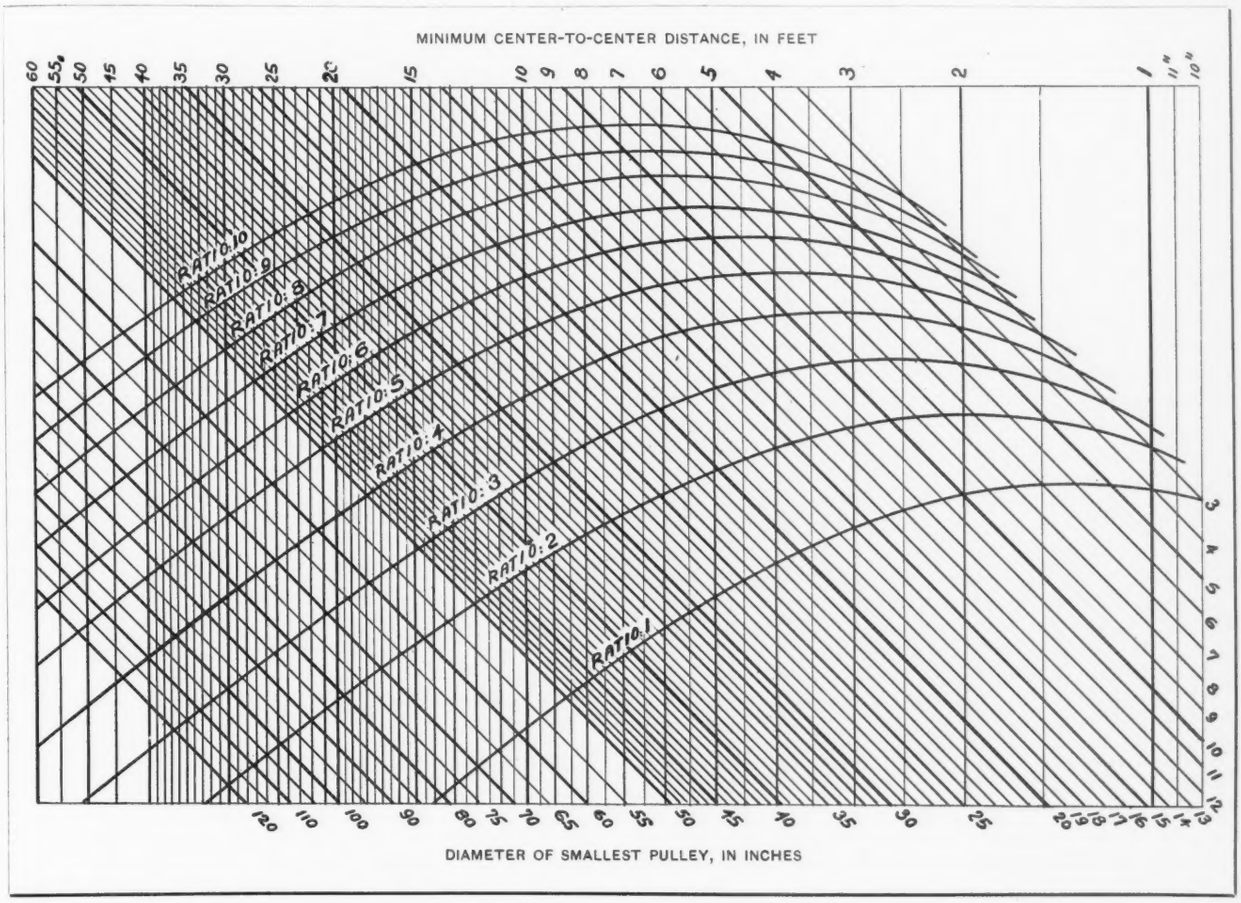


Fig. 11. Chart for determining readily the Minimum Center-to-center Distances between Pulleys for Drives of Different Ratios

How to Lay out a Short-center Belt Drive

The belt speed is an important factor in laying out a short-center belt drive, and many points have to be considered to obtain the most economical results. For speeds below 2000 feet per minute, the centrifugal tension has no great effect on the transmission of power, but manifests itself above 4000 feet per minute, where it reaches serious proportions. This, however, varies with the diameters of the pulleys. The following treatment of the "revised belt theory" is based on researches and tests covering several years of serious work. At the outset, it may be laid down, as a general rule, that the most economical operation of a belt drive is secured with a belt speed at which the greatest

effective pull, in combination with the largest ratio of tensions in the slack and tight strands of the belt, is obtained. This state is reached at a velocity of about 3000 feet per minute.

The diameter of the pulley has considerable influence on the effective pull, for the simple reason that the coefficient of friction is higher in connection with larger pulleys. The loss through creep and stiffness of the belt and the air resistance of the belt itself is less with large pulleys than with comparatively small ones. The common practice among engineers of fixing a minimum diameter of pulley for single, double, triple, and quadruple belts should be discontinued, as belt thicknesses are not standardized but vary decidedly in common use. As the diameter of the pulley affects the total stress of the belt, very satisfactory results are obtained by the use of the following empirical formulas:

$$D = \frac{\sqrt[3]{S} \times d}{0.15} \qquad (1)$$

or

$$d = \frac{D \times 0.15}{\sqrt[3]{S}} \qquad (2)$$

in which

D = diameter of pulley, in inches;
d = thickness of belt, in inches; and
S = total stress of belt per square inch, in pounds.

Minimum Center-to-center Distance

The distance between the pulley centers of a short-center belt drive is determined by the size of the pulleys and their ratio. The diameters of the driving and driven pulleys having been established to suit the given conditions, the question arises as to the proper diameter of the tension roller. Experiences with thousands of short-center belt drives have proved it to be more advantageous to have the tension roller of a different diameter from that of the driving or driven pulleys, so as to prevent bending of the belt in opposite directions on the same curvature. For this reason, the tension roller should be made of a larger diameter when the adjacent pulley (driving or driven) is comparatively small, and of a somewhat smaller diameter when the driving or driven pulley is larger.

Another consideration is the arc of contact between the belt and pulleys. There would be no advantage in having a large arc of contact on one pulley, if on the other pulley the belt embraced a much smaller portion of its circumference. Therefore the distance between the centers of the pulleys should be such that the arcs of the pulleys are the same, or nearly the same, when the drive is in operation. Although this will not be possible in every instance, the designer should make it his aim.

The chart Fig. 11 has been drawn to simplify establishing the proper centers, and the mechanical engineer will find this chart of great convenience. The curves represent the ratio of the drive, while at the top the minimum center distances, in feet, can be found. The diagonals represent the smallest pulley diameters, in inches (driving or driven),

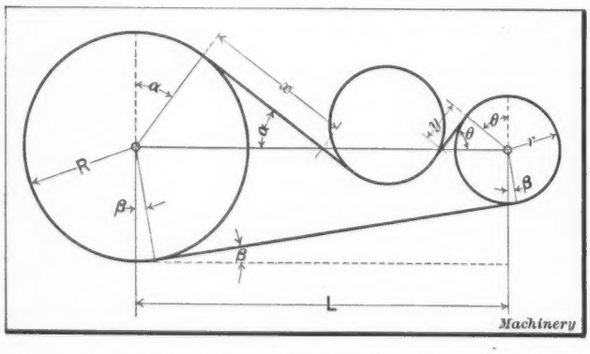


Fig. 12. Diagram showing Factors used in determining Arcs of Belt Contact on Large and Small Pulleys

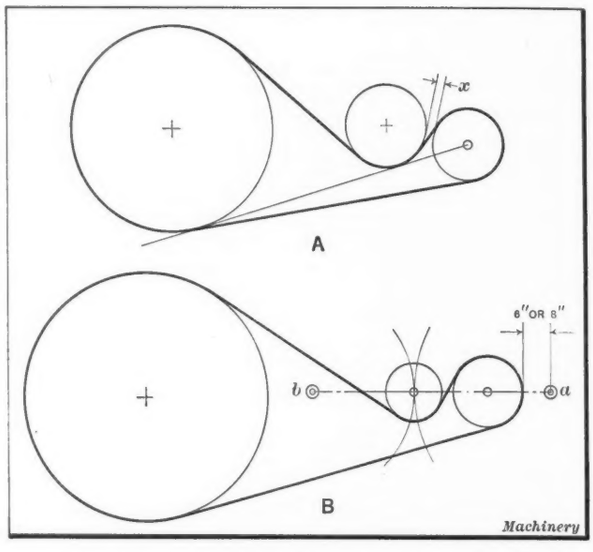


Fig. 13. Method of determining Tension Roller and Fulcrum Locations

and the vertical line passing through the point of intersection of the ratio curve and the inclined line, indicates the minimum center distance.

The arc of contact on the two pulleys can be found either by measuring them with a protractor or by using the following formulas in which

P = arc of belt contact on large pulley;
p = arc of belt contact on small pulley;
x and y = length from the point of intersection of belt line with the line connecting the centers of the pulleys, to the point of tangency of the belt on the pulley, in inches (see Fig. 12);
L = distance between centers of pulleys, in inches;
R = radius of large pulley, in inches; and
r = radius of small pulley, in inches.

$$P = 180 + \beta + a \qquad (3)$$

$$p = 180 - \beta + \theta \qquad (4)$$

$$\text{Sin } \beta = \frac{R - r}{L} \qquad \text{Tan } a = \frac{R}{x} \qquad \text{Tan } \theta = \frac{r}{y}$$

Determining Tension Roller Location and Arrangement for Given Drive

In order to locate the tension roller in the correct position, draw a line tangent to the largest pulley and to the center of the smallest pulley (see diagram *A*, Fig. 13). The tension roller should be located tangent to this line, with a distance x between the rims of the two pulleys of ¾ inch for small drives, 1 inch for medium drives, and 1½ inches for large drives. This location of the tension roller represents the average position to be used for the calculation of the belt stresses.

Having located the tension roller, the style of support for it is selected by considering the sizes of the pulleys and the space available. If there is sufficient space in front of the pulley and if this pulley is not too large in diameter, the double-arm overhung support (Fig. 7) will be the proper form to use. This style may also be used reversed in connection with ropes, if the tight strand of the belt is on the top. The location between the centers (Fig. 10) is the most suitable where space in front of the pulley is limited and where the pulleys are of such dimensions that an overhung drive would be too large.

For small belts up to 10 inches in width, the single-arm support (Fig. 6) offers a good solution on account of its simplicity and range of adjustment. The concentric support (Fig. 1) may be employed whenever there is sufficient space on the shaft for the fulcrum, irrespective of pulley diameter and width of belt. It is a nice appearing support, taking up no additional space for the fulcrum stands, and hence is recommended for main drives in engine rooms.

In order to locate the fulcrum, draw a straight line through the centers of the pulleys (diagram *B*, Fig. 13). Then place the fulcrum at *a*, about 6 or 8 inches from the pulley rim, for double-arm overhung supports. For supports between the centers, the fulcrum is placed at *b* far enough from the tension roller to clear the belt. These locations of the fulcrums are also suitable for single-arm supports. It may not be possible, in some cases, to place the fulcrum in line with the centers of the pulleys and the conditions may necessitate its location a few inches above or below this line. If this is done, see that the tension roller does not strike the pulley within the range of its action, especially if the underhung support (Fig. 9) is used. In the next installment of this series the general procedure in designing a short-center belt drive for transmitting a given amount of power will be explained.

* * *

OFFICERS OF THE GEAR MANUFACTURERS' ASSOCIATION

At the annual meeting of the American Gear Manufacturers' Association, held at Buffalo, April 28 to 30, George L. Markland, Jr., of the Philadelphia Gear Works, Philadelphia, Pa., was re-elected president; E. J. Frost, of the Frost Gear & Forge Co., Jackson, Mich., was elected first vice-president; B. F. Waterman of the Brown & Sharpe Mfg. Co., Providence, R. I., was re-elected second vice-president; and C. F. Goedke, of the William Ganschow Co., Chicago, Ill., was re-elected treasurer. T. W. Owen, 2443 Prospect Ave., Cleveland, Ohio, remains secretary. The following members were elected to serve for three years on the executive committee: F. W. Sinram, Van Dorn & Dutton Co., Cleveland, Ohio (re-elected); H. E. Eberhardt, Newark Gear Cutting Machine Co., Newark, N. J. (re-elected); A. F. Cooke, Fawcus Machine Co., Pittsburg, Pa. (re-elected); and A. C. Gleason, Gleason Works, Rochester, N. Y.

The following companies were elected to membership: A. F. Oliver Gear & Machine Co., Buffalo, N. Y., with Arthur F. Oliver as executive representative; Cloyes Gear Works, Cleveland, Ohio, with R. T. Cloyes as executive representative; Foote Gear Works, Inc., Chicago, Ill., with Bradford Foote as executive representative; and Colorado Gear Mfg. Corporation, Denver, Col., with John A. Rankin as executive representative.

The next meeting of the association will be held October 16 to 18, but the place has not yet been decided upon.

* * *

PLANS FOR MACHINE TOOL EXHIBITS

The machine tool exhibit held annually at the Mason Laboratory, Yale University, New Haven, Conn., will take place this year September 15 to 18, inclusive. These dates will permit exhibitors at the machine tool exhibition in New Haven to display their products at the International Steel Exhibition in Boston, September 22 to 26, in connection with the convention of the American Society for Steel Treating. Professor S. W. Dudley, Department of Mechanical Engineering, Sheffield Scientific School, Yale University, New Haven, is in charge of the New Haven machine tool exhibition. The exposition at Boston is in charge of W. H. Eisenman, secretary, American Society for Steel Treating, 4600 Prospect Ave., Cleveland, Ohio.

The machine tool exhibit that was to have been held in conjunction with the production meeting of the Society of Automotive Engineers in Detroit next October has been abandoned. This is not to be interpreted as a reflection of disfavor toward the exhibition, but merely as the judgment of the council that the society lacks the personnel and time to enter the exhibition field. This cancellation of the proposed exhibition will not affect the professional activities of the S. A. E., and several meetings will be held to discuss production engineering subjects during the period October 22 to 24.

VALUE OF STANDARDIZATION IN THE INDUSTRIES

The American Engineering Standards Committee, 29 W. 39th St., New York City, has published a booklet entitled "Standardization—What it is Doing for Industry," which explains briefly the object of industrial standardization, as furthered by the committee. Standardization is today one of the most important factors in increasing industrial efficiency. The magnitude of the yearly savings due to standardization is very great. These savings are to be measured, as stated by Secretary Hoover, "in hundreds of millions and billions of dollars." The actual savings that are now made in the automobile industry through organized standardization activities are estimated by the industry itself at $750,000,000 a year. This means an average saving of about $200 on every car made. The greatest waste in industry is undoubtedly due to the failure of carrying out the principles of standardization in a practical manner. It is stated, for example, that three axe manufacturers, making common axes, produce these in thirty-four types, nineteen sizes, four grades, and eleven finishes, listing, in all, 6118 varieties. The waste of making and keeping in stock such a variety of axes should be obvious to everyone.

In the booklet mentioned, it is pointed out that there are three stages of standardization: (1) within the factory; (2) within the industry; and (3) standardization of national scope. Standardization within each individual plant has been the essential factor in the development of mass production, and mass production, in turn, has been the chief contribution of the United States to the development of industry.

Standardization by industries, carried on by technical societies and trade associations, is of comparatively recent origin. The present extensive interchangeable use of electric motors and lamps would have been impossible had it not been for the collective standardization carried on within the electrical industry, whereby not only the voltages and frequencies of electric current are standardized, but also lamp bases and sockets. In the railroad field, the standardization of the gage of railroads and the system of interchangeable brakes and couplings were steps of the utmost economic importance.

Nevertheless, standardization cannot reach its greatest effectiveness until it is treated as a national problem. This has been recognized in the leading industrial countries, and has been the reason for establishing national standardization bodies. At present there are such standardization organizations in sixteen countries. In the United States this organization, which acts as a clearance house for all organized standardization work, is the American Engineering Standards Committee, 29 W. 39th St., New York City.

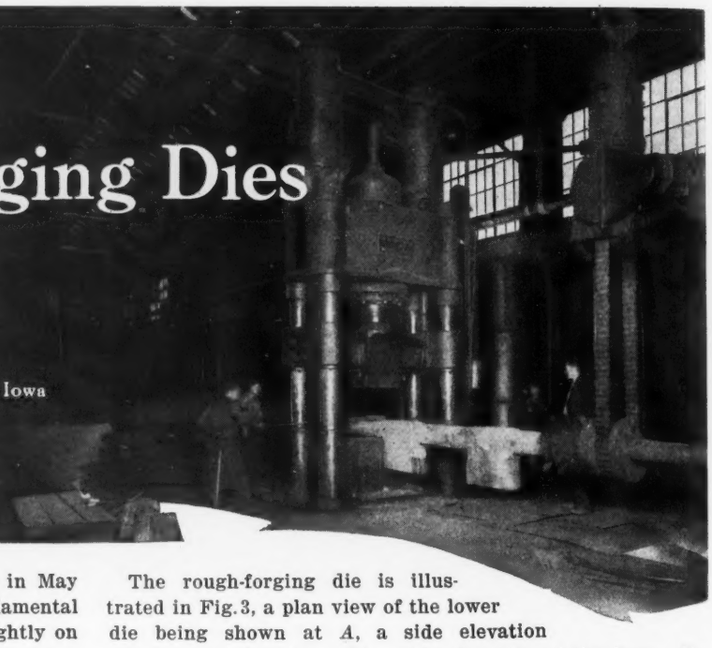
The American Engineering Standards Committee is composed of a membership including nine national engineering societies, nineteen national associations representing most of the industries of the country, and seven departments of the Government. In its first four years of activity, fifty standards have been approved and over one hundred other standardization projects have been started. Two hundred and twenty national associations or societies are officially represented on the technical committees by one thousand individuals.

Standardization like any other powerful tool is dangerous if misused; it may be begun too early, it may be carried too far, and it may be applied to improper fields. It is peculiarly important with the rapidly growing interest in the practical use of standardization that someone should be responsible for seeing that development takes place along right and reasonable lines. Standardization, if wrongly used, will produce a fixity and rigidity that will impede progress; but if rightly used it will vitalize and quicken industry, for it will release the mind and imagination from the pressure of unessential detail and the tedium of meaningless variety and give the opportunity for really worthwhile new advances.

Machine Forging Dies

A Series of Articles on the Design and Use of Forging Dies

By C. C. HERMANN
Chief Engineer, Litchfield Mfg. Co., Waterloo, Iowa



THE previous article on this subject, published in May MACHINERY, dealt, in general, with the fundamental principles of design of forging dies, touching lightly on the heat-treatment of the dies. In the present article more specific examples of drop-forging work will be taken up, and the procedure in designing the dies will be described.

The forging shown in Fig. 1 is a four-throw, three-bearing crankshaft. An examination of the illustration shows that sections *a*, *b*, *c*, and *d* are on the same center line; sections *e* and *f* are on the same center line but eccentric to the main center line of the piece; and sections *g* and *h* are on the same center line diametrically opposite sections *e* and *f*, and have the same eccentricity with reference to the main center line of the shaft. Sections *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h* are of circular cross-section, and *i*, *j*, *k*, *l*, *m*, and *n* are of rectangular cross-section.

Forging a Four-throw Crankshaft

The first point to consider in producing this part is the size of stock to be used. In this regard the designer has three methods of procedure open to him. Obviously, the part *a* is larger in diameter than any other section of the shaft; hence a bar of round stock slightly larger than the diameter required at *a* may be drawn out to give the proper size for the remainder of the shaft, or a piece of proper size for the bulk of the shaft may be upset on the end to produce the proper size at *a*. A third method, which is the one generally adopted, is to select a shaft of the required diameter and draw it down and elongate it in the breakdown operation. The object, of course, is to reduce the weight of the trimming to a minimum. In small forgings, the trimming may be as high as 35 per cent of the weight of the piece; however, in larger forgings, such as the crankshaft shown, the trimming should not represent more than 5 to 8 per cent of the weight.

At *A* in Fig. 2 is shown the bar stock which is used for producing the crankshaft by the third method mentioned. In this case the stock is slightly larger in diameter than the bearings of the finished forging. The rough forging is shown at *B*. In practice, two hammers are required to forge the shaft. The hammers are located so that they are within easy reach of one heating furnace. This arrangement permits the breakdown and the roughing impression to be made in one die on one of the hammers, and the finishing impression to be made in another die on the second hammer. Whether or not two dies and hammers are to be used depends upon the accuracy desired in the finished forging and the quantity of forgings required. When the quantity is small and the accuracy variable, the forging may be completed in a single set of dies. Modern practice favors the division of the work into three operations, namely: first, rough-forging; second, finishing; and third, trimming.

The rough-forging die is illustrated in Fig. 3, a plan view of the lower die being shown at *A*, a side elevation of the upper die at *B*, and a side elevation of the lower die at *C*. These views are taken from the right-hand side, and show the general outline of the breakdown. The heated stock is first placed in the breakdown *a*, and at the end of this part of the roughing operation, it is transferred to the roughing impression *b*. The piece then has approximately the form shown at *B*, Fig. 2. Next the forging is returned to the furnace, and when it has again been heated, it is placed in the finishing die shown in Fig. 4.

The upper member of the finishing die is shown at *A* and the lower member at *B*. The flash is shown at *e* and the back flash at *f* in the upper die. The appearance of the forging as it comes from the finishing die, ready for trimming, may be seen at *C*, Fig. 2. It will be noticed that the roughing die (Fig. 3) is not provided with flash or back flash, and also that the corners are much more rounded than in the finishing die. A cross-section of the finishing die is shown at *C* and *D*, Fig. 4, taken along the line *X*–*X*.

The crankshaft is now ready for the trimming operation which is done hot and, whenever possible, in the same heat as the finishing operation. In this case the trimming press is located within easy reach of the finishing hammer, and the work transferred direct to the trimming operation. Where the stock must be reheated for trimming, a separate furnace is generally provided.

The trimming punch and die are illustrated in Fig. 5, the die being shown at *A* and the punch at *B*. The die is preferably made in two parts to facilitate machining, and is bolted to the bed of the press. In cases such as this, the sprue is cut off in a separate operation. The impression in the punch is machined to a semicircular shape to receive the forging, and serves to guide the shaft as it is forced through the trimming die. The condition of the shaft when it leaves the trimming die is shown at *D*, Fig. 2. The shaft is now ready for the straightening operation and subsequent finishing in the machine shop.

Making the Roughing Die

In making the roughing die (Fig. 3), a bar of about 0.60 per cent carbon steel, of the proper cross-sectional area, is selected, and cut to any convenient length. After the preliminary planing operations have been completed, the bar is cut to the correct length for the die. The bars are first planed on the top surface and then down the left-hand side for a distance of about 2 inches, after which they are turned over and the bottom is planed, forming the dovetail shank to fit the machine. A cut is then taken along the front edge of the die for a depth of about 2 inches. The cuts along the front and left-hand side of the die are for the

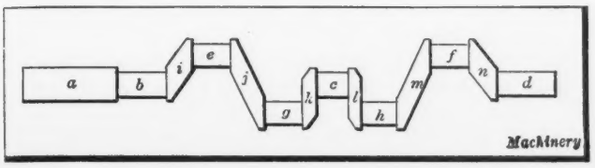


Fig. 1. Four-throw Three-bearing Crankshaft, drop-forged in the Dies shown in Figs. 3, 4, and 5

purpose of laying out the recesses and for lining up the dies on the machine. The breakdown comes on the right-hand side, and therefore the side cut is preferably made on the opposite side to avoid losing this surface when the breakdown is formed.

Before proceeding with the lay-out of the die surface, shrinkage allowances must be decided upon. Since the forging is to be hot-trimmed, a shrinkage allowance of ⅛ inch per foot is used. For cold-trimmed work, the shrinkage allowance is generally 3/16 inch. All parts of the shaft having a circular cross-section will require no additional allowance for draft, but the rectangular cross-sectional parts should have a draft of from 3 to 7 degrees. These parts of the shaft can be given ample clearance by consideration in the design. The draft allowance on thin and relatively shallow forgings is generally 3 degrees, varying to 7 degrees on such pieces as may require a deep die recess. A draft of 3 degrees corresponds to ¾ inch per foot; 5 degrees, to 1⅛ inches per foot; 7 degrees, to 1¼ inches per foot; and 10 degrees, to 2¼ inches per foot. Die-sinking machines are

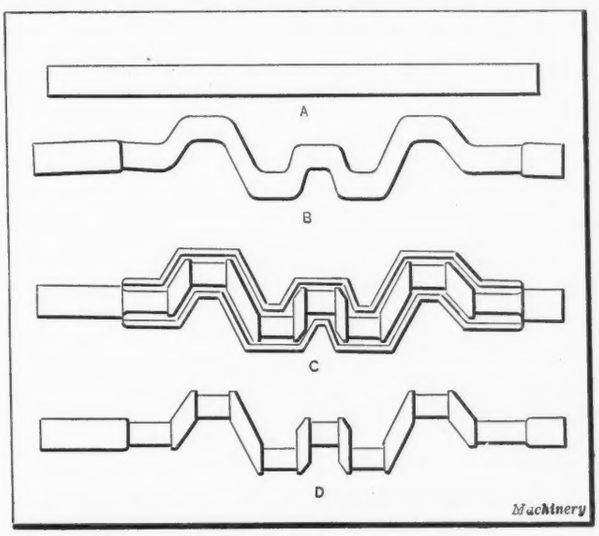


Fig. 2. (A) Bar Stock from which Crankshaft is forged; (B) Rough Forging; (C) Appearance of Shaft when it comes from Finishing Die; (D) Trimmed Crankshaft

generally equipped with cutters having a 3-, 5-, 7-, or 10-degree taper.

The die face is covered with blue vitriol or copper sulphate, and the center lines of the die are located from the left-hand side and front of the blocks. In laying out the dies, the experienced diemaker always places the heaviest end of the forging at the front to facilitate handling while working, since this permits a good sized sprue to be used. To lay out the crankshaft on the die surface, a sheet-metal templet is first cut out, and with this accurately located on the die surface, the outline is easily scribed. In this connection it should be stated that as the roughing die is made with greater curvature at the corners of the work than the finishing die, a separate templet is required for the finishing set. The roughing templet, as well as the finishing templet, can be used, however, to lay out both the upper and lower dies of the respective sets.

Making the Trimming Punch and Die

The trimming die may be laid off by the use of the lead proof described in the article in May MACHINERY, previously referred to. In the case of cold-trimming, it is preferable to use a forging as a guide in machining the die opening. Practically the only variation in the making of hot and cold trimming dies is that in hot-trimming, the sprue is cut off in a subsequent operation, while in cold-trimming, the entire scrap is removed in a single operation. In the case of large and heavy forgings, this practice may be varied by leaving

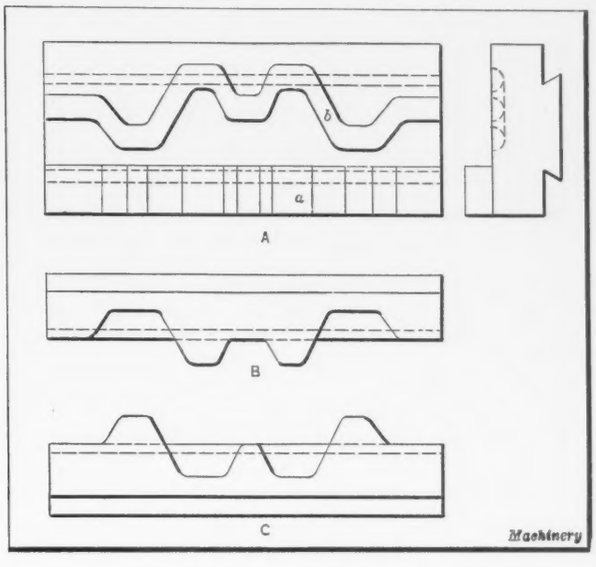


Fig. 3. Plan and Side Elevations of Upper and Lower Rough-forging Dies

the sprue to be cut off in the lathe or by some similar method.

The trimming punch is preferably made up in sections and set into the solid block. The trimming pressure is not excessive in this case, since the flash thickness would not exceed 1/16 inch. This thickness is increased next to the forging after a while, due to wear along the edge of the finishing die, but the trimming punch is constructed to take care of the additional load imposed. An advantage of the sectional construction is that it decreases the initial cost as well as the cost of repairs. The block in some cases may be made from close-grained gray iron or a semi-steel casting.

Shear must be given to the cutting edge on cold trimming dies, extending from end to end in some cases, and from end to center in very long work. When shear is given the die from center to end, as is sometimes done, the work will stretch because it is pressed downward in the center. The shear of the cutting edge is sometimes expressed as a fraction of the thickness of the metal cut; for instance, "one-half shear" indicates that the total inclination of the die face is equal to one-half of the thickness of the sheared metal. More generally, however, the shear is expressed in inches per foot of inclination. The pressure, in pounds, re-

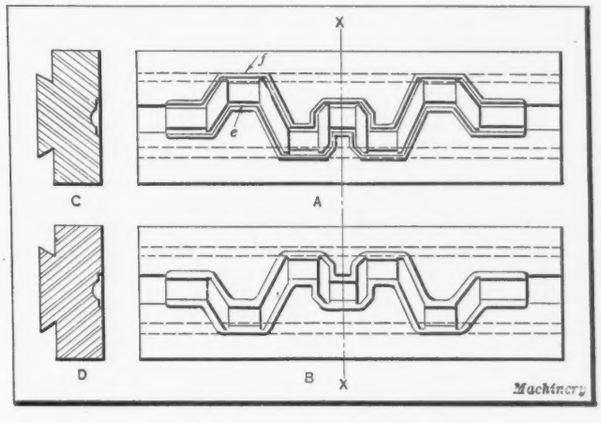


Fig. 4. Upper and Lower Finishing Dies

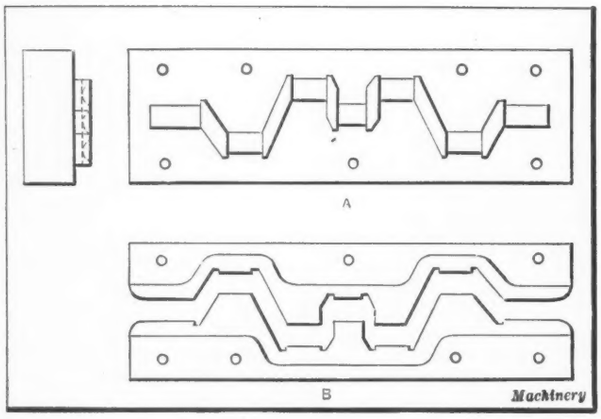


Fig. 5. Trimming Punch and Die

quired to force the forging through the die opening may be calculated by the use of the following formula: (See the article entitled, "Design and Making of Drop-forging Dies," page 35, September, 1921, MACHINERY.) Let

W = pressure, in pounds, required to shear;
t = thickness of metal, in inches;
f = ultimate shearing strength of material, in pounds per square inch, ranging from 40,000 pounds for mild steel, to 120,000 pounds for high carbon steel;
S = shear, expressed in inches per foot of inclination; and
d = a constant, generally taken as between 1/4 and 1/2, say, 1/3.

Then

$$W = \frac{6dt^2f\,(2-d)}{S}$$

A serious error in connection with templet lay-outs, to which attention should be called, is sometimes made. That is, the templet is not reversed properly when transferring from the lower to the upper die. It is first laid on the lower block, being located by the center line, and then clamped firmly to the block, after which the outline is scribed. Several combination squares are then set from each of the working surfaces of the block to the edge of the templet. The templet is next removed, reversed, and laid on the upper block, being located by the use of the combination squares, after which it is clamped firmly and the outline scribed. The outlines on both blocks are then permanently marked at intervals by prick-punches. Following this, the flash, back flash, gate, and sprue are scribed on the die surfaces and marked by a prick-punch.

To describe the entire procedure in making the dies for this example is hardly necessary. A more general treatment of the remaining essential points of drop-forge die-sinking processes will be ample, as the procedure is invariably different in each case. Each set of dies must be treated as an individual problem, and the methods applicable to one set probably would be inadequate for the next set, or too elaborate.

Sinking the Die Impression

The procedure followed in sinking the die impression depends, of course, upon the machinery available. In the larger manufacturing establishments this work is performed mechanically by means of die-sinking and special milling machines; however, many parts of the dies may be made on the ordinary engine lathe, milling machine, drilling machine, shaper, and planer. An excellent description of the Jackson and Keller die-sinking machines appeared in the article in September, 1921, MACHINERY, previously referred to, and they will be treated but briefly in the present article.

The die-sinking machine made by the Jackson Machine Tool Co., of Jackson, Mich., is similar to the regular heavy-duty vertical miller, but is provided with an additional head, and is particularly adapted to the production of semi-cylindrical impressions such as are required in the crank-shaft dies. The second head carries the cherrying tool, and imparts an oscillatory movement to it. The tool is lifted from the impression at the end of the cutting stroke and lowered into it at the end of the return stroke. By feeding the table under the cherrying tool, a semi-cylindrical impression of varying length and radius can be machined.

A die-sinking machine incorporating the principle of the profiling machine, in which an exact model or master pattern of the impression to be made is utilized, is made by the Keller Mechanical Engineering Corporation, of Brooklyn, N. Y. In this machine the upper part of a swinging frame carries a tracer which moves in contact with the surface of the master pattern or model, and thereby guides the revolving cutter over the work. In one style of this machine, the model used is of the same dimensions as the die produced, while in another, which is particularly adapted to more intricate designs, a larger pattern is utilized. In the latter type, two revolving plates are used. The master pattern is mounted on one of these and the die-block on the other. The bar that supports the tracing point and the cutting tool is adjustable, and so mounted that it may swing in a horizontal or vertical plane as the tracer moves over the contour of the master. By reversing the positions of the master and the die-block, an enlargement rather than a reduction may be effected.

Die-sinking Tools

A large variety of milling tools called "cherries" are available for use in die-sinking machines. These tools are made with taper shanks to fit the spindles of the machine, or with straight shanks to fit a given chuck, as required. The length of the arbor varies to suit the work. A tool known as a "point," having a pointed center and a shank that fits the regular holding device, may be used advantageously for lining up the spindle of the die-sinking machine with a given mark on the die surface, such as a center mark. The "point" may then be removed and the required cutter inserted. Such tools as "hogs" or roughing cutters are used for roughing out the impression, and these are followed by finishing cutters. Cherries are made to almost any form required to suit the impression to be cut in the die-block. Cherries are best suited for use in a special cherrying attachment on the die-sinking machine, but they may also be used to advantage on a universal miller.

Very few dies can be finished entirely by machine, but require some hand work, such as chiseling, filing, scraping, or riffling. Almost every toolmaker is familiar with the

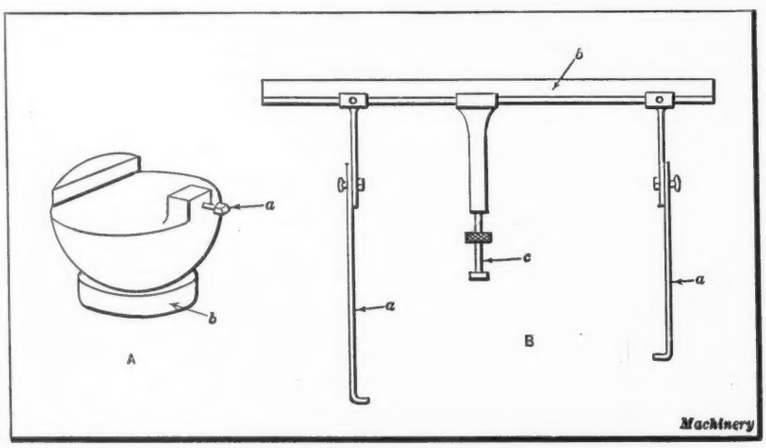


Fig. 6. (A) Ball Vise for holding Work while chipping, riffling, polishing, etc.; (B) Templet-holder for clamping Templet to Die-block

ordinary methods of using these tools, and hence they will only be treated lightly here. After a given amount of scraping has been done, the impression is usually finished by riffling. Riffling tools are made in many different shapes, the more common being spoon, hook, knife, flat, and half-round.

When the die recesses are deep and narrow, and it is impossible or at least difficult to scrape or riffle them to a finish, small blocks of steel known as "types" are utilized. The ends of these blocks or types are shaped exactly like the part of the forging to be formed. After the recess is shaped out in the usual manner as far as possible, the type is rubbed lightly with prussian blue or other marking material, and placed in the recess. A piece of sheet copper is then put over the end of the type, after which it is struck a hard blow with a hammer. The marking material adheres to the high places of the recess, and these high places are then removed by chipping, after which the part is finished by riffling.

A ball vise, such as shown at *A*, in Fig. 6, is found advantageous in performing the operations of chipping, scraping, riffling, typing, and polishing. Such a vise serves to hold the work in almost any position while working on the impression. The die-block is clamped in place by the set-screw *a*, and the vise rests on a pad of leather *b*, mounted on the bench.

The templet-holder shown at *B* in Fig. 6 is convenient for holding or clamping the templet to the die-block while scribing the outlines. It consists of legs *a* which are adjusted on bar *b* to fit the die. An adjustable screw *c* is also mounted on bar *b*, which serves to press the templet firmly against the die surface after the holder has been fastened in place as well as possible by adjusting the thumb-screws on legs *a*.

* * *

HEAT-TREATMENT DEFINITIONS

The American Society for Testing Materials, the American Society for Steel Treating, and the Society of Automotive Engineers each approved some years ago definitions for certain terms relating to the heat-treatment of steel. These definitions varied considerably. With a view to harmonizing these several sets of definitions, a committee was appointed, consisting of representatives of the organizations mentioned. After several meetings and considerable correspondence, the members of the committee found it impossible to agree upon a set of definitions meeting the various viewpoints presented. Separate reports were therefore submitted to the societies by the three members of the committee. The definitions adopted by the Recommended Practice Committee of the American Society for Steel Treating were published in April MACHINERY on page 612. In the following are given definitions submitted to the members of the Iron and Steel Division of the Society of Automotive Engineers. It will be seen that these differ somewhat from those proposed by the American Society for Steel Treating.

Heat-treatment—The change, or the series of changes, in temperature, and also the rate of change from one temperature to another, brought about to secure certain desired conditions or properties in a substance.

Annealing—A form of heat-treatment for the purpose of softening, or relieving strains, or both.

1. *Annealing with Grain Refinement*—Heating to a temperature above the critical range for hypereutectoid or eutectoid steels or above the lower limit of the range for hypereutectoid steels followed by relatively slow cooling through that range.

Note: This does not give so fine a grain as quenching.

2. *Normalizing*—Heating to a temperature above the critical range to secure more uniform distribution of the structural constituents, followed by relatively slow cooling through that range in still air at room temperature.

Note: This term is generally restricted to such treatment as applied to hypereutectoid steels.

3. *Spheroidizing*—Prolonged heating at a temperature slightly below the critical range to produce coagulation of the cementite into globules, usually followed by relatively slow cooling.

4. *For Softening or Relieving Strains*—Heating to a temperature not necessarily sufficient to refine the grain, followed by relatively slow cooling if necessary.

5. *Drawing*—Reheating, after quenching, to some temperature below the critical range, followed by any permissible rate of cooling.

Note: The use of this term to indicate heating without previous quenching should be avoided; the term "annealing" should be employed in such a case.

6. *Tempering*—Reheating, after hardening by quenching, to some temperature considerably below the critical range, followed by any permissible rate of cooling.

Note: Drawing and tempering are practically synonymous in commercial practice.

By "critical range" is meant the A_c range on heating and the A_r range on cooling. In view of the different applications of the term "annealing," it is recommended that the specific treatment intended be stated unless clearly indicated.

Quenching—Rapid cooling.

Quenching for Hardening—Rapid cooling, through the critical range, to a temperature not exceeding that which subsequently may be employed for drawing or tempering.

Carburizing by Cementation—Adding carbon to steel or wrought iron by heating the metal below its melting point in contact with carbonaceous material.

Note: The term "carbonizing" used in this sense is undesirable and should be avoided.

Casehardening—Carburizing, and subsequently hardening by suitable heat-treatment, the outer portion of an object.

Case—The outer, carburized portion of a casehardened object.

Core—The inner, uncarburized portion of a casehardened object.

Cyaniding—A method of surface hardening whereby the object, or a portion of it, is heated and brought into contact with a cyanide salt, followed by suitable heat-treatment.

The principal causes for differences of opinion among the members of the committee may probably be traced to certain conditions, as, for example, facing the definitions on methods employed and not on purposes to be accomplished; restricting a general term to a single specific application; presenting a restricted definition as though it were general; not recognizing as heat-treatment any operation directly connected with mechanical working.

The complete report submitted has been sent to the members of the Iron and Steel Division of the Society of Automotive Engineers in mimeograph form, and copies can be obtained from the society by those who wish to make a comparative study of the definitions now under consideration by the American Society for Steel Treating, the American Society for Testing Materials, and the Iron and Steel Division of the Society of Automotive Engineers.

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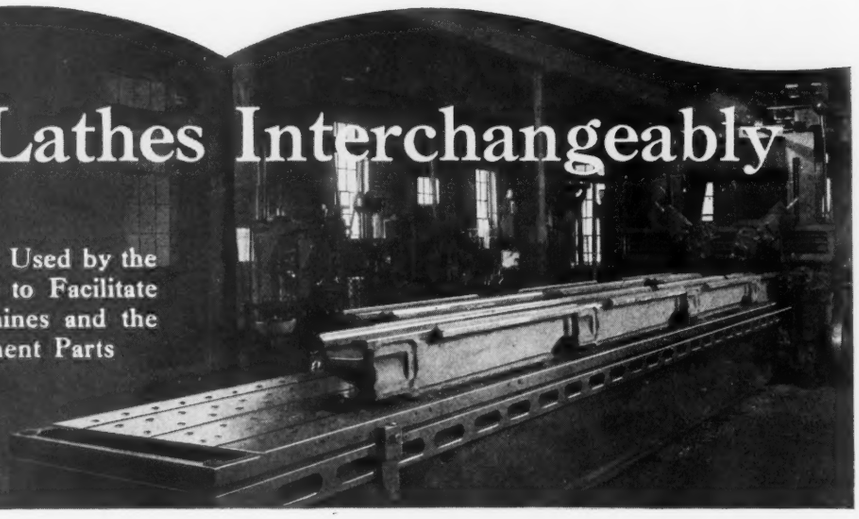
MACHINE TOOL EXHIBIT AT ATLANTIC CITY

In connection with the convention of the American Railway Association at Atlantic City, June 11 to 18, an extensive exhibition of machine tools, small tools, and shop and railway equipment will be held. The exhibition space covers approximately 103,000 square feet, excluding the aisles. Among the exhibitors will be not less than 45 machine tool builders making almost every line of machine tools, in addition to a great number of small tool and general shop equipment manufacturers. Without question, this is the largest exhibition of its kind to be held during the year, and a very important opportunity is provided for those interested in machine shop equipment, not only to see this equipment on exhibition, but to see a great deal of it in operation.

Building Lathes Interchangeably

Manufacturing Methods Used by the Chard Lathe Company to Facilitate the Assembly of Machines and the Supply of Replacement Parts



By CHARLES O. HERB

AN important point to remember in planning to build any standard line of machines is that a prospective customer is more likely to be attracted by the machines if he knows that the builder will always be in a position to furnish replacement parts that do not require hand-fitting. When the Chard Lathe Co., New Castle, Ind., was established approximately ten years ago, interchangeable methods of manufacture were instituted, and as a result, it is stated that any part of any size lathe built in the past can be duplicated and applied to the machine without hand-fitting. In addition to this, the assembly of the lathes is made easier, because any headstock of a group, for instance, will fit all beds of the same size lathe equally well. While some of the methods used in this plant are also employed in other shops, many of them the writer believes to be entirely original. The more interesting ones will be described in this article.

Planing the Beds to Masters

A number of beds are generally planed at one time by mounting them in two rows on a planer equipped with a table 30 feet long and using both tool-heads on the cross-rail and a head on each side of the table. The heading illustration shows seven 6-foot beds for 16-inch lathes arranged on a machine of this type. The first step in planing a group of beds consists of taking roughing and finishing cuts on the bottom, with each bed carefully shimmed level and clamped to the table. After the bottom has been finished, the beds are set up for machining the vees and flat surfaces on the top and several surfaces on the sides. These various surfaces are all machined to masters, one of which is mounted on the planer table in front of each row of beds, as illustrated at *A* and *B*, Fig. 1. Each of these masters is mounted on a base provided with an inserted tongue which enters a slot in the planer table. The masters are adjustable both sidewise and vertically for aligning with the work, and the tools are located from the master when taking each cut. In setting the tools for the final finishing cut, a 0.005-inch feeler gage is laid on the master and the tool touched against this gage, the master being 0.005 inch smaller all over than the finished bed section should be.

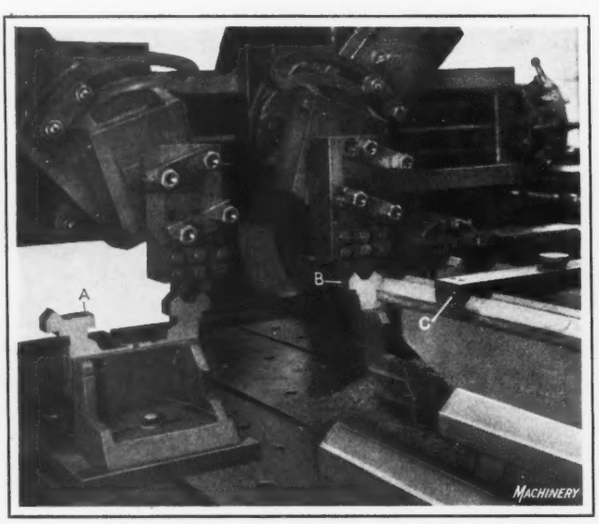


Fig. 1. Planing Lathe Beds to Masters attached to the Planer Table

In rough-planing the top of the beds, cuts are taken until the tools are ⅛ inch away from the master surfaces, after which the beds are loosened to relieve all strains incident to the planing. The beds are then reset and shimmed up carefully until a height reading taken at each corner of each bed by means of an indicator will be the same at all corners. Each bed is then clamped and a reading again taken at all four corners to make sure that the bed has not been sprung in clamping. The beds are next semi-finished to within 1/32 inch of the master surfaces, and then again released to relieve strains and reset a third time by employing an indicator as before. When cuts have been taken until all surfaces are within 0.005 inch of similar surfaces on the masters, readings are again taken on all four corners of each bed before and after unclamping.

In rough-planing the vees, a plain round-nosed tool is used to facilitate breaking through the scale. In the semi-finished planing, six tools are used at one time, two on each cross-rail head, for planing the ways, and one on each side-head. In the final cut on the vees, square-nosed tools are used with the heads swiveled at an angle, as shown in Fig. 1. The permissible variation in parallelism is only 0.0005 inch per foot of bed length. Straightness is determined by means of a Brown & Sharpe straightedge and pieces of tissue paper.

The finished vees of each bed are checked by means of a templet, such as shown at *C*, Fig. 1. This templet has two vee grooves to suit the double vees of the bed, and a half vee groove that must register solid with the adjacent side of the vee on the opposite side of the bed. There are also "half" templets with slanting surfaces which must register closely on opposite sides of two vees. In addition to these, there is a test gage for determining the distance that a machined surface on one side of the bed is below the side of the vee, and a gage for checking the height of the vees above the adjacent flat surfaces.

Masters for Headstocks, Aprons, Carriages, etc.

Interchangeability of the headstocks, carriages, aprons, compound rests, and tailstocks is assured by planing these parts to masters in a manner similar to that fol-

lowed in planing the beds. The carriages are first rough-planed on the top or dovetail side while held in a special fixture. They are then turned over, carefully shimmed up until level, as shown by applying an indicator at the four corners, and rough-planed on the side that fits the bed. Next they are set aside for about ten days to season, and then set up and finish-planed on this side to a master and templet.

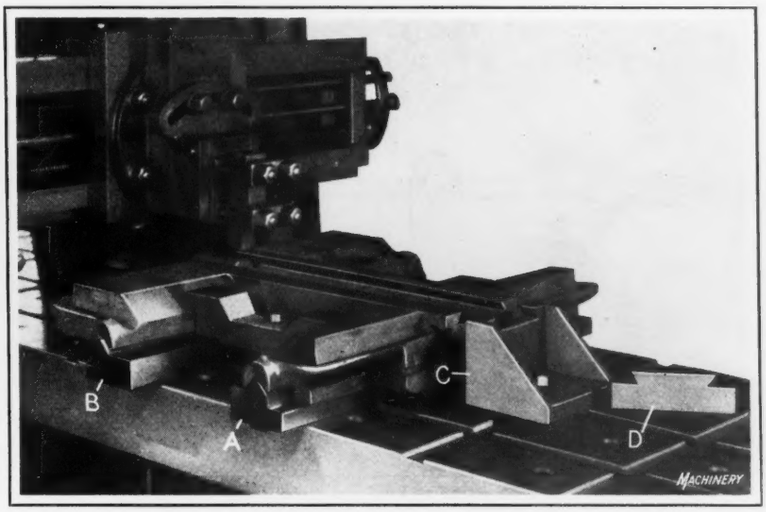


Fig. 2. Finishing the Dovetail of a Carriage to a Master while held on Vee Parallels which insure Subsequent Alignment with the Bed

For the finish-planing operation on the dovetail, the carriages are brought to the machine illustrated in Fig. 2, on which accurate slots have been milled transversely across the table. Into one of these slots is fitted the tongue on the bottom of a parallel *A* which has a vee on the upper side identical with a vee on the bed for which the carriage is intended. There is a second parallel vee, but this parallel does not have a tongue, being loose on the table to permit movement as the carriage casting expands during the operation. The carriage is planed on these parallels with the previously finished vee grooves resting on the vees of the parallels. By means of this set-up the carriage dovetail is "planed to its bed," and the operation is so accurately accomplished that hand-scraping is not required to align the carriage with the bed. The dovetail is planed to master *C* and templet *D*.

After being removed from this planer, the carriage is drilled, reamed, and tapped, as required, jigs being used for each step. It is next painted and then sent to the vise department where the dovetail side is scraped to a master plate, principally for the sake of appearance. The corners are slightly rounded and polished at the same time.

Finishing Flat Surfaces by Grinding

An unusual operation in lathe building that has reduced production costs and yet has actually increased the accuracy of the surfaces machined is the surface-grinding of certain parts. Fig. 3 illustrates this operation being performed on the tops of carriage wings with the carriage mounted on vee parallels similar in design to those used on the planing operation just described. However, in this case neither parallel is locked to the table, except with large sized carriages. To facilitate the grinding, the wing surfaces are left somewhat higher than the flat surfaces adjacent to the dovetail.

This operation averages about fifteen minutes, whereas when the wings were polished by hand, it required from three to four hours. Besides this saving in machining time, the surfaces are so accurately produced relative to the bed vees that a surface gage may be used on the wings for laying off heights in tool-room work. It is claimed that the surfaces also remain accurate longer because of being glazed in the grinding. This same method of finishing is also used for covers; the lever pads of gear boxes; the reverse lever pad of aprons; the bearing sides and edges of compound rest bottom slides, swivels, and top slides; the surface of tailstock bases where the top is attached; and the name on the headstock and other nomenclature.

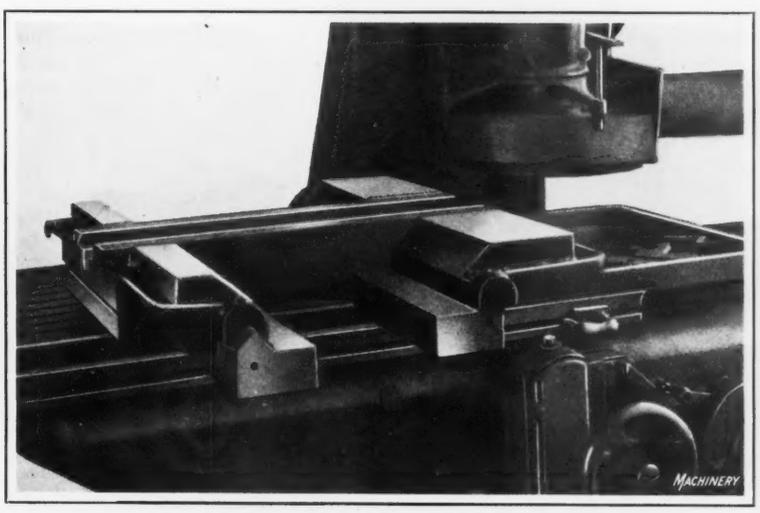


Fig. 3. Surface-grinding the Top of the Carriage Wings

Finish-boring the Headstock Bearings

The spindle bearings of the headstocks are first rough-bored while held in a fixture on a boring mill and then finish-bored by hand on the fixture shown in Fig. 4. The bed of this fixture has a vee that accurately locates the headstock relative to the boring-bar, the opposite side of the headstock seating on a flat surface. At the left-hand end the boring-bar has a fine thread of forty-eight threads per inch, with which a split nut is engaged to feed the boring-bar longitudinally through the headstock as the handle at the right-hand end is revolved.

In boring the headstock casting in this manner, about 0.015 inch of metal is removed all around. Then white metal bearing castings are assembled and bored in the same way, about 0.020 inch of metal being removed all around. The bearings are not scraped, and yet are generally true within 0.00025 inch for their entire length. After a head is completed, a test bar is inserted in the spindle nose to determine the accuracy of spindle rotation. This test bar projects 17 inches from the spindle nose, and with an indicator applied to the overhanging end, it must rotate concentrically within 0.001 inch. Even then the error cannot be below nor in front of the center.

It will be noticed that there is a second set of holes for the boring-bar in back of the first set, which is used in boring the back-gear bearings on headstocks intended for lathes of that design. It will be obvious that fixtures of this type are required for all the different sizes of lathes. Tailstocks are bored in the same fixture and with the same bar as the headstocks for the same size lathe, in order to insure the alignment of their spindles when the headstock and tailstock are assembled on a bed.

A novel means has been devised to insure that all turned parts will be fin-

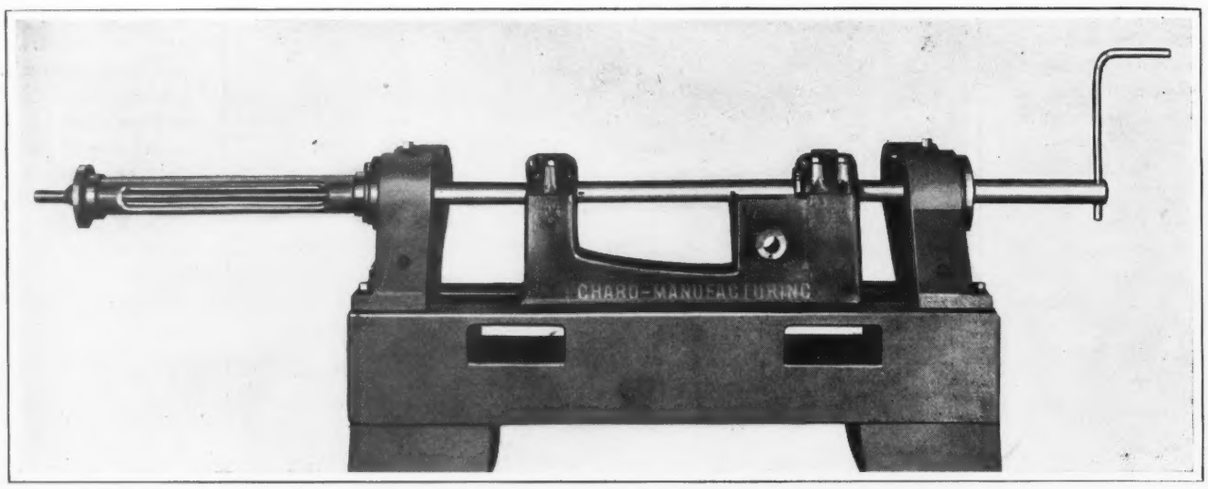


Fig. 4. Special Fixture used for finish-boring the Headstock and Tailstock Bearings

ished accurately to size. Instead of the machine operators turning to calipers, micrometers, or snap gages, they simply set the tool in a finishing cut according to a pin mounted on a collar that is slipped over the tailstock spindle, as shown in Fig. 5. These pins are hardened at the projecting end and ground to the finished radius of the particular surface they are intended for, minus 0.005 inch.

In setting the tool for the final cut, a 0.005-inch feeler gage is laid on the pin and the tool is brought into contact with this gage. In the illustration the tool is shown touching one pin preparatory to turning the periphery of the gear, but in actual practice the feeler gage would be inserted between the pin and the tool. The upper long pin on the collar and the short pin are used in turning other parts. For work of smaller diameter, a large number of pins is frequently mounted on one collar, and for very small work, the collar is made to fit the tailstock center.

Insuring Accurate Facing of Parts

Similar means are taken to insure that all parts will be faced to length within very close limits. All parts that have a central hole are mounted on a plug arbor which is hardened on the end and ground accurately to length. In taking the finish-facing cut, the operator merely touches the end of the arbor with the tool before engaging the cross-feed. In Fig. 5 the end of this plug arbor may be seen a short distance within the edge of the hub. For all pieces having a multiple number of diameters that do not vary too much, and where the surfaces are not too long, there is a gang tool-block which holds all the tools that are required.

The accurate facing of shouldered work held between centers is performed by applying a spacing bar *A*, Fig. 6, to the lathe on which the work is turned. One end of this bar is inserted in a hole bored in the front right-hand wing of the carriage, and it is locked to the carriage by means of a simple vertical pin. Cut in the opposite end of the bar are annular grooves which are spaced the same amount as the various shoulders on the work. This end of the bar is supported by a stationary bracket attached to the bed, on which is mounted a handle *B*. The lower edge of this handle comes in contact with the spacing bar and drops successively into the different grooves as the carriage is fed to the left. When the lever drops into a groove, the carriage feed is automatically disengaged, and thus the operator is informed that the particular surface being turned has been machined to the required length. He then advances the tool on the rear side of the cross-slide to face the shoulder. After setting the front tool for taking the next cut, either by means of the micrometer diameter stop shown mounted on the front end of the cross-feed screw, or by means of a pin collar on the tailstock spindle, the operator lifts handle *B* and engages the feed for turning the next surface.

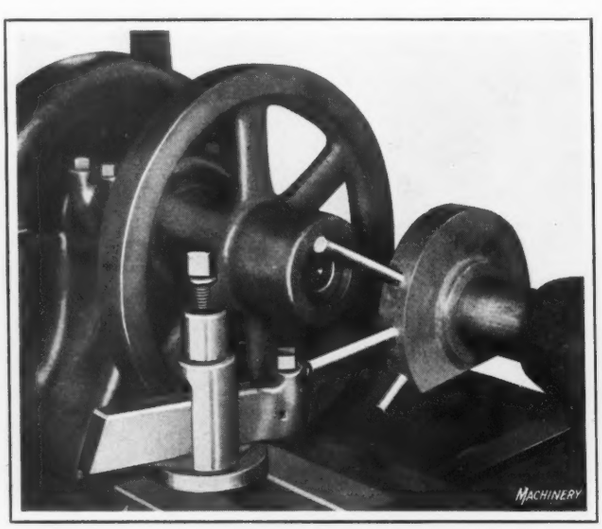


Fig. 5. Use of Pins and Arbors for accurately turning to Diameter and facing to Length, respectively

Methods such as these were originally necessary because of the fact that when the Chard Lathe Co. established itself in New Castle there was a scarcity of machinists in that vicinity and unskilled men had to be employed. The methods have been continued because they practically eliminate spoiled work and insure the interchangeability of parts.

Cutting the Lead and Cross-feed Screws

One of the most important operations in lathe-building is the making of the lead-screw, because even when all the parts are closely aligned, if accurate threads cannot be cut, the machine will not be a desirable one. In cutting the lead-screw in this plant, it is well supported by a follow-rest mounted on the carriage of the lathe close to each side of the cross-slide, as shown in Fig. 7. With this arrangement the span at the point of the cut is not more than 6 inches, and so distortion and inaccurate threads are reduced to the minimum. The follow-rests have jaws that bear on the outside diameter of the screw and are adjustable to compensate for wear. Of course, different jaws must be provided for each different diameter of lead-screw. The tools in the front tool-block cut on the forward travel of the carriage, and the tool on the rear block cuts during the return travel.

Stops for limiting the depth of cut are provided on the carriage for both the front and rear tools. These stops are set by means of a transverse screw between the cross-slide and the right-hand follow-rest. Dogs on the cross-slide come in contact with these stops and control the depth of the lead-screw thread. The handle on the

stop-screw is graduated to thousandths of an inch. In order to permit the lead-screw to expand freely during the threading operation without distortion, the right-hand end of the screw is left free to move longitudinally in a bushing in the tailstock. The lead-screw is first threaded to within 1/32 inch of size, and then seasoned for at least two weeks before finish-chasing to gages. Lead-screws made in this plant range from 6 to 31 feet in length.

There are also several points of interest in cutting the cross-feed screw. This operation is illustrated in Fig. 8. It will be seen that the screw is held in a draw-in collet at the headstock end, and on a special center at the opposite end. The main point of interest is the provision of a bar at the rear of the machine, which is supported at the left-hand end by being inserted into the front back gear bearing of the headstock, and at the opposite end by a bracket attached to the tailstock spindle. Mounted on this bar are four or more brackets containing jaws which contact with the work and support it rigidly against the thrust of the cut. The jaws are adjustable back and forth, and as they are bored to the outside diameter of the screw being cut, different jaws are necessary for the various diameters of screws. Two cuts are taken at one time on the thread, a roughing cut on the bottom and a finishing cut on each side.

Although only a few of the operations in the plant have been described, the methods explained are typical of those used on all parts. There is a special jig or tool for each part so that the operator cannot spoil the work. Drill jigs are of the box type wherever possible, because box jigs can be rolled over with the work held rigid, and these jigs also hold their accuracy longer than other styles. The size of holes on all Chard lathes have been standardized to a few diameters so as to reduce the stock of drills, reamers, and taps. Taking the apron as an example, only nine tools are required for drilling and reaming it complete. When the apron has been reamed, a master set of gears on studs are mounted on it so as to make certain that the jig has not lost its accuracy. There is a master apron in the gear department for testing the meshing of gears, and a master headstock and gearbox for the same purpose. Special tools insure accurate thrust collars, the limits on these parts being held particularly close.

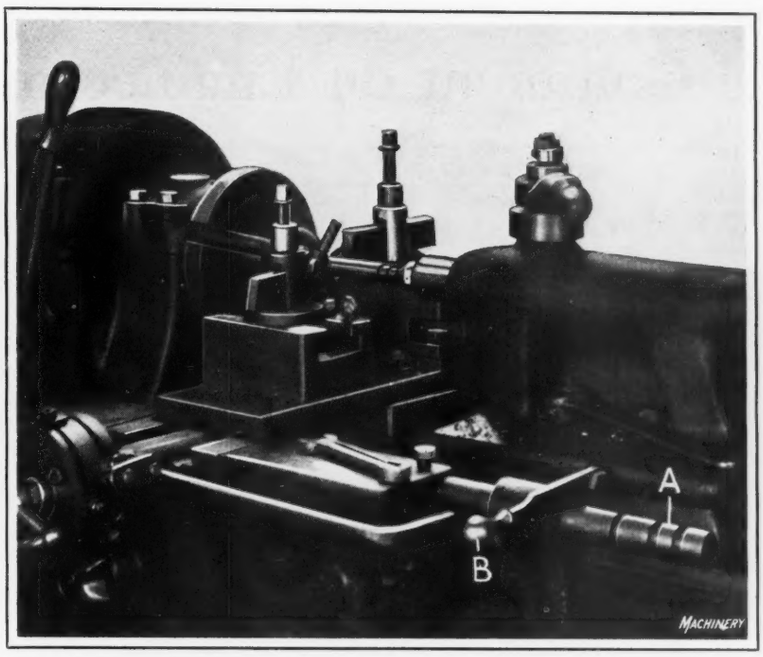


Fig. 6. Spacing Bar applied to Lathe for accurately controlling the Length of Surfaces of Shouldered Work

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As far as known, only thirteen airplane engines rated at more than 600 horsepower have actually been designed and built. Seven of these engines are of French design; three are British; two, American; and one, Italian. In the United States an 18-cylinder type of aircraft engine has been designed and built, which is composed of three rows of six cylinders each, with an included angle of 40 degrees between each of the outer rows and the vertical row in the center. The first one of these engines was completed over three years ago. The rated horsepower of this engine was 750 at 800 revolutions per minute, but the first dynamometer tests showed a much greater power output. The original engine completed five 50-hour endurance tests. It is believed that never before has the first airplane engine built from any design been known to make such a record. The weight of this engine is 1770 pounds, and as it will give normally 800 horsepower, the weight is approximately 2.21 pounds per horsepower. Improvements on this engine have, of course, been made since that time, and the U. S. Army air service now possesses one of the best bombing plane engines yet developed, together with experience that indicates that successful engines of 1000 to 1500 horsepower can be built to weigh less than 1.5 pounds per horsepower.

* * *

The Swedish machinery industry is gradually recuperating after the very severe depression that followed the war. The locomotive shops are especially active; a contract to deliver 500 locomotives to the Russian government will be filled by August this year, and new orders for export business have been received from Brazil and the Balkan states, as well as domestic orders for the Swedish state railways.

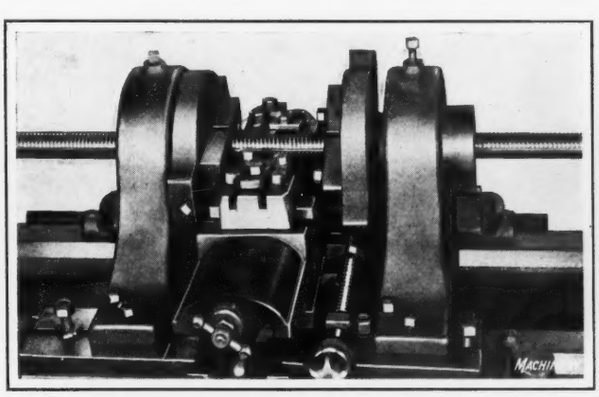

Fig. 7. Set-up of Tools and Follow-rests for chasing the Thread on a Lead-screw

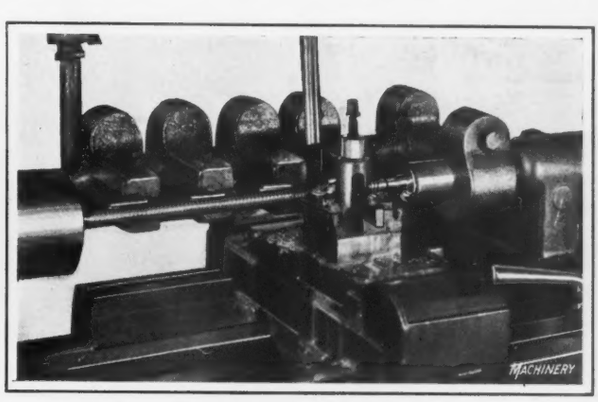

Fig. 8. Chasing a Cross-feed Screw with the Work rigidly supported by Brackets

Notes and Comment on Engineering Topics

Road-building has become one of the great and important activities in this country. We are now spending annually about $1,000,000 for road construction, and the demand for still better roads is insistent and growing. The investment in automobiles is approximately $4,000,000,000 a year, and the annual operating cost is estimated at about the same figure.

In a paper recently read before the American Petroleum Institute by J. M. Johnson of the Missouri-Kansas Railway, it is stated that 1088 pounds of oil has been found equivalent to 2000 pounds of coal in oil-burning locomotives. Although the cost of coal at the mine is less than that of its equivalent of oil at the refinery, the use of oil has led to economies because of cheaper handling costs and simplified operation.

A new radio station has been erected in Poland near Warsaw. This station is the first in Europe to make use of the Alexanderson high-frequency alternator now used in all Radio Corporation stations for trans-atlantic communications. A similar station is being built in Sweden and is expected to be ready for operation by mid-summer. These two new stations will not only serve their own countries with an adequate and quick means of communication with America and other nations, but will also tend to link eastern Europe more closely with the United States.

In the past, rolls for nearly all the cold-rolling of strip and sheet metal were made of chilled iron. Recently, however, this material has been replaced by hardened, ground, and polished rolls of alloy steel, containing chromium, chromium and vanadium, chromium and molybdenum, or all three metals, as well as chromium, tungsten, and vanadium. It is stated that rolls made from these materials can be made much harder than chilled iron rolls. They also take a higher finish, producing a correspondingly better surface on the product. Molybdenum steel is also employed for rolls in blooming mills and roughing mills.

The French Government has approved the building of a railroad across the Sahara Desert, an undertaking which it is expected will take seven or eight years. This railroad will connect Oran in French Morocco with Wagadugu near the Gold Coast. Stretching 1750 miles from the Mediterranean to the Niger, passing directly across the immense desert, the Trans-Saharan Railway will be an achievement almost as important as the Trans-Siberian Railroad. An interesting feature of the proposed road is that for most of its length it will be necessary to run pipe lines, or maintain some conduit system connecting with deep artesian wells, to insure a constant water supply.

Nickel as a chemical element was discovered by the Swedish chemist Cronstedt in 1751, but more than a century elapsed before any important use was made of this metal. In fact, it was regarded as a rare metal until the discovery of the New Caledonian deposits about 1890. Today nickel is one of the most important of the metals, because of the added strength obtainable in steel by a small addition of nickel. The nickel ore deposits of the world are not numerous, but where nickel is available it is sometimes found in great abundance. Among the most important nickel ore deposits are those found in Ontario, Canada. Canada produces between 80 and 85 per cent of the total world's supply of nickel. The United States imports about 80 per cent of the Canadian output.

The industrial output of many of the European countries is smaller than in the years before the war, because trade relations have been disturbed and the daily hours of labor have been deliberately reduced. Yet the people of the nations whose industrial output has been reduced are dissatisfied with any lowering of the standard of living; during the war and since, they have formed a habit of refusing to adjust themselves to conditions which they regard as hard and unusual, and believe that their respective governments can create relief by the mere enactment of laws. In spite of the conditions, however, an improvement is noted in that in practically every European country outside of Germany, and possibly Russia, production and trade was larger in 1923 than in 1922, and, in fact, larger than in any year since the business depression following the war began.

If the standard sizes for wrench-head bolts and nuts that have been developed from present practice by the sectional committee on the standardization of bolt, nut, and rivet proportions of the American Society of Mechanical Engineers are finally approved, only 24 wrench openings will be required for the nuts in the range from a No. 5 machine screw to a 3-inch bolt. This is a reduction of approximately 50 per cent in the present wrench sizes. A tentative report of this committee, covering eight 9- by 12-inch pages, has been generally distributed for criticism and comment by manufacturers and users of hexagonal and square-head bolts and their corresponding nuts. The report consists of two pages of text, seven tables showing present and proposed standards, and four diagrams in which the proposed series is compared with present American practice and that of Great Britain and Germany. Those desiring one or more copies of this pamphlet may secure them by addressing C. B. LePage, the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

The historical records that our age will leave to posterity will include moving picture films that will enable coming generations to get a much clearer view of the present industrial development of our civilization than mere written records could ever convey. Scenes from a number of metal trades and machinery plants will be included in a collection of films that Watterson R. Rothacker of the Rothacker Film Mfg. Co., Chicago, Ill., has presented to the Smithsonian Institute for preservation. The scenes will be selected with a view to giving people centuries hence a comprehensive picture of the state of the industries early in the twentieth century. Until recently it has been seriously doubted whether a motion picture could be preserved for future generations, but means have now been found whereby films can be "aged" so that the result is the same as if they were hundreds of years old. In this way it is possible to determine not only that films can be preserved, but that by certain processes they can be rejuvenated so as to give perfect results thousands of years from now. It is understood that Mr. Rothacker will stipulate that the vault in which these films are deposited shall not be unsealed for 5000 years.

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WEIGHTS OF CASTINGS

DETERMINING WEIGHTS OF CASTINGS FROM WEIGHTS OF BEECHWOOD OR MAHOGANY PATTERNS

Weight of Pattern, in Pounds	Type of Castings					
	Cast Iron	Yellow Brass	Gun Metal	Zinc	Copper	Aluminum
5	43	48	50	41	51	16
10	85	95	100	82	101	31
15	128	143	150	123	152	47
20	170	190	200	164	202	62
25	213	238	250	205	253	78
30	255	286	300	246	303	93
35	298	334	350	287	354	109
40	340	380	400	328	404	124
45	382	428	450	369	455	140
50	425	475	500	410	505	155
55	468	523	550	451	556	171
60	510	570	600	492	606	186
65	553	618	650	533	657	202
70	595	665	700	574	707	217
75	638	713	750	615	758	233
80	680	760	800	656	809	249
85	723	808	850	697	860	264
90	765	856	900	738	910	279
95	808	904	950	779	960	294
100	850	950	1000	820	1010	310
105	893	998	1050	861	1061	326
110	935	1046	1100	902	1112	341
115	978	1092	1150	943	1163	356
120	1020	1140	1200	985	1213	372
125	1063	1188	1250	1026	1264	388

In the table above, the weight of beechwood or mahogany patterns is multiplied by 8.5 to obtain the weight of cast iron; by 9.5 for yellow brass; by 10 for gun metal; by 8.2 for zinc; by 10.1 for copper; and by 3.1 for aluminum castings. The figures in the table are to be used as a general guide only, because an appreciable difference in the specific gravity of different pieces of the same kind of wood is frequently found. When very accurate estimates are required, the specific gravity of the metal from which the casting is made must be ascertained, and the volume of the casting carefully calculated.

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WEIGHTS OF CASTINGS

WEIGHTS OF CASTINGS FROM WEIGHTS OF CHERRY PATTERNS

Weight of Pattern, in Pounds	Type of Castings					
	Cast Iron	Yellow Brass	Gun Metal	Zinc	Copper	Aluminum
5	54	60	63	52	64	20
10	107	120	126	104	128	39
15	161	180	189	156	192	59
20	214	240	252	208	256	78
25	268	300	315	260	320	98
30	321	360	378	312	384	117
35	375	420	442	364	448	137
40	428	480	505	416	512	156
45	482	540	568	468	576	176
50	535	600	630	520	640	195
55	588	660	693	572	704	215
60	642	720	756	624	768	234
65	695	780	820	676	832	254
70	750	840	883	728	896	273
75	803	900	946	780	960	293
80	856	960	1009	832	1024	312
85	910	1020	1072	884	1088	332
90	963	1080	1135	936	1152	351
95	1017	1140	1198	988	1216	370
100	1070	1200	1260	1040	1280	390
105	1123	1260	1323	1092	1344	410
110	1176	1320	1386	1144	1408	430
115	1230	1380	1449	1196	1472	448
120	1283	1440	1512	1248	1536	468
125	1336	1500	1575	1300	1600	488

In the table above, the weight of a cherry pattern is multiplied by 10.7 to obtain the weight of cast iron; by 12 for yellow brass; by 12.6 for gun metal; by 10.4 for zinc; by 12.8 for copper; and by 3.9 for aluminum castings. The figures in the table are to be used as a general guide only, because an appreciable difference in the specific gravity of different pieces of the same kind of wood is frequently found. When very accurate estimates are required, the specific gravity of the metal from which the casting is made must be ascertained, and the volume of the casting calculated with considerable care and accuracy.

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MACHINERY'S DATA SHEETS Nos. 35 and 36

Proposed Increases in Postal Rates

EVERY person engaged in industry, whether as employer or employe, executive or manual worker, will be affected by the legislation introduced into Congress by Congressman Griest and Congressman Paige if their proposals become the law of the land. The Griest bill is concerned mainly with increasing the salaries of postal employes—a worthy cause, provided these increases are based on facts. The Government should not expect, and the people certainly do not wish, to have its work done for less than private employers pay for the same kind of service. The people of this country are characteristically fair and liberal, and they want to pay government employes a just wage and give them fair treatment. But because the Government is the employer, it should not be obliged to pay more for similar services than is paid in the same localities by private employers to men whose work is often more exacting and less secure. Justice and consideration to Post Office employes and justice to the users of the postal service, that is, all the people, demands due consideration of both sides.

How it is Proposed to Raise the Money

In order to raise the money to provide for the increases in pay to postal employes, the Paige bill proposes to increase some of the postage rates. But instead of making a careful and scientific analysis to ascertain what would be wise, just, and equitable, based upon operating costs and other considerations connected with the service, the Paige bill proposes to saddle the entire expense heavily upon industry by arbitrarily increasing the parcel post rates and the rates on periodicals. In some instances the proposed rates are three times as high as the present rates.

Postmaster-General New, the responsible head of the Post Office Department, has advised against proceeding in this manner. His department has been investigating operating costs for the purpose of readjusting all postal charges on a scientific and equitable basis. He urges that no change be made in postal rates until the report of his department is completed, which will probably be in July or August. This should commend itself to everyone. It is the right method of solving the problem of raising increased revenue to meet increased postal expenses.

Hasty Action Should be Discouraged

If salaries in the postal service are to be increased (and we believe that in some cases they should be), the increase will be put upon a surer, more equitable, and permanent basis if it is made *after* the report of the committee investigating the facts has been carefully studied. A hasty passage of the measures now before Congress, involving very heavy increases in certain classes of postal rates, would not necessarily produce the required revenue; for such increases are more than likely to effect such a decrease in the volume of business handled, that the Post Office would lose greatly instead of making the needed gains.

Readers of MACHINERY may be interested in learning that while, in 1916, a copy of MACHINERY could be sent to a subscriber in Chicago for 2½ cents, it now costs 15 cents—that is to say, it costs $1.80 a year merely to deliver to a subscriber in that zone his twelve numbers of MACHINERY, where it used to cost only 30 cents. It used to cost only 30 cents a year to send MACHINERY to a reader in California; now it costs $3 a year; and as the subscription price is only $3 a year, the whole amount the subscriber pays for the periodical goes to the Post Office!

Readers of technical and trade journals, interested in maintaining these publications on a sound financial basis, so that they can continue to serve the industries and the hosts of men employed in them, are urged to write to their Senators and Congressmen in Washington, protesting against hasty and merely political legislation, and advocating that the report of the Postmaster-General be made the basis for any changes in postal rates. His plan aims to increase efficiency and to distribute the costs equitably in accordance with the ascertained facts.

Effect of Increases in Publishing Costs

During the past three years there has been heavy mortality among periodicals, especially the smaller ones. High costs, including the very heavy postal rates, have killed them. Most of the leading technical journals have operated at a loss on account of the great reduction in the volume of advertising, coupled with permanently increased costs. The politician who sees in a periodical like MACHINERY a considerable volume of advertising immediately assumes that the publication makes a large profit, but he does not realize that publishers of such periodicals have, in a field of intense competition, passed the advertising revenue on to the reader in a journalistic service developed to an extent that would amaze the editor and publisher of only twenty-five years ago. From the meager and flimsy sheets of earlier days these periodicals have developed a service for the cost of which the reader pays only an infinitesimal percentage; and as the advertiser buys his advertising space in a field of intense competition he gets it at a rate which leaves the publisher less than the average net return that comes to any established competitive industry.

The American Society of Mechanical Engineers has been investigating the increased cost of printing. The figures quoted below show the percentages of increase since 1914 in the production of *Mechanical Engineering*—the journal of the society—and, of course, apply equally to the production costs of other technical publications.

Percentage of Increase in Publishing Costs Since 1914

Machine Composition...105	Engravings (based on per square-inch rate).....110
Hand Composition.....218	Engravings (based on minimum sizes).....275
Presswork.....170	
Binding.....118	

Postage rates alone were increased 275 per cent as a war measure, and while other forms of war taxation have been reduced this remains. Now the proposal is to increase the rates still more. Periodicals can continue to exist in the face of these constant increases only by increasing their subscription and advertising rates. But industries and individuals have enough burdens now and are looking to our legislators to effect the necessary economies that will bring relief instead of new loads to carry. The President has made this clear.

We believe our readers agree with us that the facts should be ascertained before proceeding, even in the year of a presidential election; and we hope they will express their opinions by writing their representatives in Congress, urging them to withhold action until the matter has been fully investigated.

Only a few months ago the country was thrilled by the official and well-advertised promise of economy and tax reduction. In this single item, an increase in postal salaries estimated at $65,000,000, we have the promise of a heavy additional tax on the people to come in the form of increased postal rates. MACHINERY believes in a just wage, and there should be early but well-considered action on behalf of all underpaid postal employes; but the Postmaster-General has the right idea—get the facts first!

EDITORIAL COMMENT

on Mechanical Subjects of Current Interest

THE COST OF MAKING REPAIR PARTS

At some of the regional meetings recently held by the National Machine Tool Builders' Association, it developed that the cost of making repair parts for old machines was often greater than the price charged, and that it is a common experience for machine tool builders to lose money on repair parts. This is particularly true when the repairs are for machines that are no longer built. In such cases high-priced men are often required to look up records and drawings that have been stored away; and the passing of single pieces through the shops adds materially to the cost and frequently interferes with other manufacturing schedules.

If users of machine tools insist upon keeping obsolete machines in operation, the machine tool builders are at least entitled to raise the prices on repair parts to cover the cost and a moderate profit. When repair parts for machines can be obtained at less than cost, this may look like a good reason for continuing to use the old tools; but it is really a poor reason, because while the repairs may be cheap, the limited output and inaccuracy of the old machines usually make it impossible to keep down production costs.

Recently our attention was called to a lathe forty years old, which is still kept in operation, although the ways are so worn that when the lathe is used for boring, the hole at various points of its length may be "out of true" as much as 1/16 inch. Whenever the old lathe is used, the operator must spend considerable time and care watching his cut, taking special precautions to guard against the errors of the machine. It is incredible that the owners of a machine shop do not see that they are losing money daily by not scrapping such old tools. The joker who once proposed that a law be passed prohibiting the use of any machine tools over twenty years old, wasn't so wrong, after all, for possibly the enforcement of such a law would actually save money for a great many machine tool users who insist upon keeping their obsolete, money-losing tools in operation.

* * *

UNNECESSARY ACCURACY

In interchangeable manufacturing to limits, the first essential is the ability to measure to those limits accurately. This point was emphasized by Mr. B. H. Blood, of the Pratt & Whitney Co., in a paper presented before the Machine Shop Division of the American Society of Mechanical Engineers at Philadelphia, and seems so self-evident as to require no comment. Yet manufacturers producing parts for outside customers continually receive drawings on which tolerances are given that cannot possibly be checked, or that demand so high a degree of accuracy as to prevent production on a commercial scale. Very often these small tolerances are given because of ignorance of manufacturing conditions, in the belief that high-class work is thereby assured.

In an example illustrating this practice, drawings were furnished for a complete tooling equipment. The specifications accompanying the drawings contained this clause: "All workmanship to be of the highest quality and all dimensions to an accuracy of 0.0001 inch." The job included the making of drill jigs as large as an ordinary writing desk top, and tools and gages of various dimensions. If the work had been done strictly according to the specifications, it would not have been completed to this day, although the order was placed some six years ago. As a matter of fact, the tools were made and put in service in a few months at a cost of somewhat more than $100,000, although a strict adherence to the specifications would have brought the cost into millions.

This extreme example is cited merely to show the danger of placing unnecessarily close limits on parts, or of drawing up specifications without a thorough understanding of the requirements and functions of the machines or tools to be made. While it is true that much careless work is done in our factories when greater accuracy would improve the product, it is also a fact that large amounts of money are wasted annually by insisting upon extreme accuracy that serves no useful purpose. We have seen drawings on which parts that "fit in the air" are given tolerances of one-thousandth of an inch. We have known of manufacturers who order taps held within one-half of a thousandth in lead and pitch diameter, when the screws fitting into the tapped holes vary 0.005 of an inch in size, and we have known of buyers ordering work finished with a clearance of 0.0001 of an inch when such accuracy actually made it impossible to fit the parts together with the freedom required for the functioning of the machine.

More judgment is needed on the part of those who are responsible for placing tolerances and limits on drawings. If less time and money were spent on unnecessary accuracy, more effort could be applied to securing accuracy where it is really essential. It is not sufficient to guess at the tolerances—it is necessary to actually study the action of the machines to be built in order to determine the accuracy required for each part.

* * *

MODERN GRINDING WHEEL SERVICE

In the early days of the application of grinding in the machinery industry, the user himself generally had to experiment with the limited number of wheels then available, to determine which were best adapted to his conditions. Now, although the number of wheels kept in stock is very large, even the inexperienced user need not spend much time in experimental work, for the leading grinding wheel manufacturers maintain service departments to give advice on the selection of grinding wheels for any purpose.

In the past, while great care was used in selecting wheels for precision grinding in the machine shop, it was generally thought that the selection of wheels for rough work in the foundry was of no great importance, and usually a wheel was used that lasted a long time, thereby reducing wheel costs. Therefore, until the wheel manufacturer began researches in the foundry field, costs therein were much greater than they should have been, because while the wheels in use were long-lived, their production was less than the right kind of wheel is capable of. The service departments of the leading grinding wheel manufacturers, in experimenting with wheels for the rough-grinding of castings, have developed wheels capable of both high production and durability, the results being a material reduction in the total grinding costs.

These service departments also give advice when new conditions are encountered in grinding. Sometimes these arise from the introduction of new metals, and sometimes through the introduction of new grinding machines or grinding methods. In every case the wheel manufacturer is called upon to supply the best wheel for the service, and through the extensive research and service departments now maintained, he is able to do this most satisfactorily.

Prospects of the Machine Tool Industry

Address Delivered before the National Machine Tool Builders' Association, by Ralph E. Flanders, of the Jones & Lamson Machine Co., President of the Association, at the Convention in Buffalo, May 22

WE have had a year or more of general prosperity in the industries, tempered by dissatisfaction in the farming areas. The industrial prosperity has been such as to permit of record-breaking business in some branches—notably in the steel industry, in transportation, in electrical machinery, and in the automotive lines. All of these branches are important customers of the machine tool industry. Yet our barometer shows that the average rate of machine tool output for 1923 did not exceed 36 per cent of that for the first quarter of 1920, which is taken as a normal period; and the average rate for the first four months of 1924 is somewhat less. Now general industry itself is slowing down, and the prospect looks still more dubious. What is the reason, and what is the remedy?

Fluctuations in the Machine Tool Industry

In accord with the trend of the times, and assisted by the work of our capable manager, Mr. DuBrul, we have all been getting a clearer picture of the real character of the machine tool industry and of its relation to the general economic situation. We know that its product is several "removes" distant from the ultimate consumer, and is therefore subject to violent fluctuations in demand, unknown to the producer of flour, shoes, and news-print paper. People must have some provision of food, clothing and shelter, even in the hardest times, if they are to exist at all; but the country can run on for many months without new machine tools—and in hard times it does it.

Furthermore, the demand for machine tools to make the machinery to make the ultimate product does not appear for some months after the demand for the product itself shows a marked increase; but the machine tool market drops off instantly under the first chill breath of an expected recession of demand on the part of the ultimate consumer. The periods of high demand are thus much shorter than those of other industries, as well as more violent. All of this is now a commonplace in our own conception of things, however little it may be understood by our customers. There does, nevertheless, seem to be need for a still more fundamental examination of our situation, if we are to steer a true course in the coming months and years.

Basic Factors Influencing the Machine Tool Industry

The first basic factor in our situation is that our normal rate of output has in the past been largely absorbed by the expansion of industry in this country. Replacement and maintenance of existing equipment would call for a comparatively small percentage of the available machine tool building capacity.

The second basic factor is that the United States has definitely entered on a new era in its economic history—one in which we may safely predict that the rate of industrial expansion will be slower, to a marked degree, than it has been in the last fifty years. The causes of this slower rate of expansion are two: (1) the disappearance of public lands of agricultural value; and (2) the practical stoppage of immigration.

Of these phenomena, the taking up of the public lands is the more obscure in its effects, but it is not the less certain or important. A country with a constantly advancing frontier is of necessity a country of expansion. It is a country of growing population, with increasing demands for clothing, shelter, and implements of all sorts. In ways that we well understand, this is reflected in increasing requirements for machine tools.

The stoppage of immigration is an indirect result of the disappearance of valuable public lands. It is only in part due to a fear that our institutions are endangered by the incoming mass of aliens, with ideas and ideals foreign to our culture. The real driving power of the sentiment behind restriction is the subconscious appreciation in the mind of the average citizen of a change in living conditions—of a gradual increase in the severity of competition. He is no longer willing or able to cope with immigrants of lower economic standards, whatever their social standards may be.

Lessened immigration evidently slows up the increase of population and thus directly restrains industrial expansion and machine tool demand. It does the same thing indirectly by cutting off the available supply of rough labor, and thus hindering many large engineering and constructional projects, which if put through to completion, would have a beneficial effect on our business.

Foreign Demand and the Prospect of Future Developments

There are, of course, other causes of the depression in which we find ourselves. There is little foreign demand in the countries that used to be good customers. The industrial and economic disorganization of the war has but recently shown signs of recovery. The newer industrial countries—Japan, India, and China—have not developed rapidly enough to fill the places of our older customers.

And then there is a final factor, fascinating, but highly problematical. It may be that we are approaching the end of the age of invention. This has often been prophesied in the past, always with resulting discomfiture to the prophet. But it does clearly appear that the most spectacular inventions of our day are of less human significance than the humbler developments of past generations. We are on the eve of a thirty-six hour aerial mail service between New York and San Francisco—a truly astonishing development, involving problems of organization and scientific research undreamed of sixty years ago. And yet it is scarcely that length of time since the first crude railroad connection displaced the "covered wagon" on the overland trail. Can this recent event by any possibility have the effect on the history of our country that the earlier one did?

Millions listen nightly to the eerie magnifications of invisible, inaudible, immeasurable pulsations of the ether. We call it the "radio." Powerful sending stations girdle the earth; it remains the highest triumph of scientific imagination and analysis. But will it revolutionize the history of the world as did its humbler progenitors, the first steam boat and the Atlantic cable? Do not thoughts like these drive us to the conclusion that the real work of the coming age lies in the perfecting of the social structure—the solving of the problems of the production and distribution of wealth, along lines which will enhance the general health and happiness of the average man and his family?

What is Ahead for the Machine Tool Industry?

But I am digressing. It is proper that I should return to a consideration of the state of the machine tool business, and of the policies to which that state directs us. It is sufficient if the more general discussion has emphasized two facts: First, that our industry is only in part a barometer

of business activity but that it is preeminently a barometer of business expansion; second, that it is sensitive to major social movements quite beyond our control. We must adapt ourselves cheerfully to new conditions, for there is no hope in any attempt to pull backward up the stream of history.

The present condition, then, is that our industry has grown to supply the needs of a general industrial expansion (which has for the present slowed down)—plus the needs of an acute war-time expansion, which we devoutly pray may never come again. What are the prospects for getting business to employ our idle plant, equipment and workmen? Let us explore the possible channels of improvement.

In the first place, there is always the hope of some new and rapidly growing development, as typified by the bicycle and later by the automobile. The truck, the tractor, and the airplane have, in turn, been hailed as worthy successors to the first two, but so far their influence has been disappointing. They may be counted on, however, for a more or less steady growth which will produce benefits measurable in the long run.

There will also be a steady growth of our machine-made civilization, quite irrespective of an increase of population. Added to this expansion of civilization will be a certain degree of expansion of population, due to natural increase irrespective of immigration. This will demand its small share of industrial expansion, with a consequent demand for our product.

Scarcity of Labor will Increase Demand for Machinery

Furthermore, in judging of the effect of restricted immigration, we have to reckon with the fact that it will directly increase the demand for machinery, thus compensating, in part, for the indirect influence already described. So-called "rough labor" is slowly but steadily disappearing from the fair face of our land. The Italian, the Hungarian, the Pole, the Russian, are leaving the ranks of the day laborers and climbing the social ladder. There is plenty of room at the bottom, with no one to fill the room. The last ten years have seen a remarkable development in contractor's and other types of machinery designed to fill the place of the day laborer. That development is bound to continue.

In road-building, for example, the work formerly done by three men and five dollars worth of equipment, is today done by one man and five thousand dollars worth of equipment. An expenditure of capital is required for the modern method one thousand times greater than was needed in the old day. While this ratio is unusual, it but emphasizes the fact that the diminishing forces of rough labor can only be replaced by an enormously increasing investment. The present situation, under which the great reservoirs of capital are poured into tax-free bonds rather than into the channels of industry, constitutes the largest single handicap to the prosperity of manufacturer, workman, and farmer.

Last on the list, but not least, are the opportunities offered by the replacement of obsolete equipment. Many factors are required to bring success along this line. Among them are: A product kept up to date, of the best possible design, materials, and workmanship, in view of all the requirements of the situation; specialized, intelligent, persistent salesmanship, to overcome lethargy and skepticism; a farsighted viewpoint on the part of the customer; and, finally, as in the previous instance, conditions favorable to an abundant supply of capital for industrial improvement.

Prospects for the Immediate Future

My prophecy for the immediate future would be that we are faced by several months of business that will be neither desperately bad nor "rather poor," but somewhere in between. Beyond that point the indications on which I have elaborated appear to point to a gradual improvement extending over a period of years. We may reach our full capacity in three or four years, or it may take ten to fifteen. The question of how long it will take to arrive at the desired consummation depends mainly on two elements—a wise measure of tax reform, and an increase in confidence and fair dealing between the various elements of the social structure.

The advance in business during this period will not be uniform. The cyclic fluctuations will still continue, but with lessened violence. The high points will not be so high, nor the low points so low, as in years past. The lesson of the business cycle is being learned, and every individual manufacturer who adjusts his own business to it assists in soothing its perturbations.

* * *

THE SERVICE OF THE GEAR CUTTING MANUFACTURER

In his paper "The Gear Manufacturer Needed," read by L. G. Hewins, sales manager of the Van Dorn & Dutton Co., Cleveland, Ohio, before the annual meeting of the American Gear Manufacturers' Association at Buffalo, N. Y., Mr. Hewins gave a number of reasons why manufacturers generally are able to obtain a cheaper and better product by purchasing their gear requirements from concerns that specialize in gear-cutting than by cutting their gears in their own plants:

1. The quality of the gears obtained from the gear manufacturer is better because he has greater experience, being a specialist.

2. Gear specialists can furnish gears more economically, because in a great many plants not regularly employed in the cutting of gears, the gear equipment is idle a large part of the time. Idle machines take up floor space; they depreciate whether idle or busy; they require cleaning and attention; they must be insured—and in a dozen ways like this they increase the overhead.

3. In some plants there is gear-cutting enough to keep the machines busy, say, 50 to 75 per cent of the time. In such cases there is a tendency on the part of the operators of these machines to slow down, so that the work will last throughout the year. This is only human nature and an act of self-protection, because a man does not want to work himself out of a job; but this procedure increases the manufacturer's labor costs. The gear specialist can reduce this labor cost as a direct result of the fact that he can keep his gear-cutting machines busy 100 per cent of the time.

4. The slow turnover of material and labor investment increases the cost of gears cut in the manufacturer's own shop. It may be that in order to have his gears available when needed and to avoid tying up too large an investment in equipment, he must make a quantity of gears months before the time that they are required, thus tying up an unnecessarily large amount of capital.

5. From time to time manufacturers need to increase their production schedules. When they are buying gears from dependable gear-cutting specialists they have the advantage of a flexible arrangement; otherwise they may find it necessary to equip their shop with enough gear-cutting machines to take care of their peak load, and much of this equipment will then stand idle a large part of the time. The gear manufacturer whose entire plant consists of gear-cutting machines and who serves hundreds of customers, can adjust his production to these peaks and valleys.

6. Another source of reduced economy is found in the fact that machines that are used only part of the time will possibly become obsolete long before they are worn out. They are not likely to be scrapped at that time, however, but will be used in spite of their inefficiency, thereby increasing gear-cutting costs. The gear-cutting specialist, using his equipment all the time, wears out his machines before they become obsolete and hence has a more up-to-date equipment.

7. Sometimes a manufacturer needs ordinary gears and heat-treated or hardened gears in the same machine. If he has no heat-treating facilities, he is tempted to use ordinary gears throughout the machine and thereby lower the quality of his product. The gear manufacturer is equipped to furnish any type of gear most suitable for the service required.

National Machine Tool Builders' Convention

THE spring convention of the National Machine Tool Builders' Association was held Thursday and Friday, May 22 and 23, at the Hotel Statler, Buffalo. At the meeting a great many problems relating to the machine tool industry, of importance both in relation to production and sales, were discussed. Ralph E. Flanders, manager, Jones & Lamson Machine Co., Springfield, Vt., president of the association, devoted his presidential address to a discussion of the various factors that will influence the future of the machine tool industry. This address will be found on page 765 of this number of MACHINERY. W. A. Viall, secretary, Brown & Sharpe Mfg. Co., Providence, R. I., spoke on some of the current problems of the industry. Other addresses made before the convention were as follows: "Methods of Analyzing the Machine Tool Market," and "The Automotive Field as a Near-time Prospective Market for Machine Tools," by Harry Tipper, secretary, Class Journal Publishing Co., New York City; "Foreign Markets: A Survey of European Markets," by W. H. Rastall, chief, Industrial Machinery Division, Department of Commerce of the United States; "Control by Budget System," by P. E. Bliss, vice-president, Warner & Swasey Co., Cleveland, Ohio; "Simplified Cost Keeping," by H. P. Dix, secretary, Wilmarth & Morman Co., Grand Rapids, Mich.; "Cooperative Selling," by George C. Purdy, president, Greenlee Bros. & Co., Rockford, Ill.; and "Shop Lay-out and its Relation to Cost Keeping, and Control of Overhead," by Ralph E. Flanders, manager, Jones & Lamson Machine Co., Springfield, Vt.

A very complete report was presented by Ernest F. DuBrul, general manager of the association. In this report Mr. DuBrul stated that in the machine tool industry the average of orders for the first four months of 1923 was 41.4 per cent of the monthly average of the first quarter of 1920. The first four months of this year averaged 33.8 per cent of the 1920 base average, or only about 80 per cent of the same period last year. The industry as a whole did not show much if any return for 1923. Coming after such two years of great losses as 1921 and 1922, it is worth while to give thought to some of the problems that still confront the machine tool industry. In January 1921, 222 companies were listed in the association's membership; of these 57 have either left the machine tool field, or are in the hands of receivers, or creditors' committees. It is no wonder, then, that some machine tool builders are distressed over present and prospective conditions. But the world will still need some master tools of industry, and they will be furnished by the companies whose executives are fighting with their brains. Purchases during last year were largely of high-production machines that made old processes obsolete by great reductions in the cost of doing work.

Need for Careful Planning for the Future of the Industry

Continuing his report, Mr. DuBrul stated that in order to stay in business, the machine tool builder must consider it a necessary part of his regular operations to be designing newer and better machines. It is his job to transfer more and more skill and intelligence from his men into the machines they build. That means making machine tools more and more automatic.

The big financial problem today is what to do with the excess capacity that exists here and there in the industry. In some cases it is a liability, and not an asset. The question is: What can be done successfully? There are not many things that all can do. Some can bring out new and revolutionary designs that will create some new demand. Perhaps all could improve salesmanship. The better the salesman, the more orders will follow his trail. If the salesman is working for a distributor, the manufacturer has no control over him, but intelligent pressure on the distributor will do something to improve selling service. Some can make other products to help carry the load. Others can combine their talents and resources, making one good organization out of several poorer ones, concentrating operations in fewer shops and better ones, and thereby reducing costs.

One thing cannot be done successfully, judging from experience, and that is to clear an over-supply of machine tools by bargain sales below cost. The bargain sale does not increase demand, because men buy machine tools only as needed to produce other goods, and making disastrous prices on machine tools has no perceptible effect on the demand for the product of the tools. Nor can one profitably capture enough market in dull times to fill up his shop while his competitors sleep. Trying to do so simply creates demoralization, and ends in the bankruptcy of a whole industry. Cut-throat competition has never yet been found to be a social benefit. It is uneconomic, because it is wasteful of capital previously accumulated. Many a concern, wrecked by foolish cut-throat policy, could have prospered had its executives taken time and thought to analyze its problems and to find a true and sensible solution for them. No industry requires more managerial ability or more high grade salesmanship than the machine tool industry, and particularly so at this time of stress.

Necessity for Research

Each industry must solve that industry's problems. A whole industry's problems are solved quickest and best by exchanging information, reporting experience as to successful and unsuccessful methods, and cooperating in business and technical research. That involves real association work. No individual can get along as fast or as far by depending on himself alone. How fast and how far an industry gets along will depend in great measure on how much it does along cooperative lines. Other industries of far less importance, with far less at stake than the machine tool industry, have found it very profitable to spend large sums on cooperative work. The machine tool industry needs more activity in, and definite programs for the standardization of tool-holding and work-holding elements; the elimination of unnecessary sizes; technical research that will show all how to make better machine tools; financial research that will show all how best to manage the finances of a machine tool business; and market research that will show all how best to sell the master tools of industry.

Metric System Agitation

The so-called "World Trade Club" of San Francisco persuaded the directors of the Chamber of Commerce of the United States to ask the council of the chamber to advise if a chamber referendum should be had this year on the compulsory adoption of the metric system. At the meeting of the council in Cleveland, on May 5, a plausible pro-metric argument was made on behalf of the World Trade Club's resolution, asking the chamber to take a referendum. The negative side was presented by your Mr. DuBrul, and with very little more discussion the question was put to a vote and was overwhelmingly defeated. "Judging from comments made after the session," said Mr. DuBrul, "it appears that the pro-metric propaganda is like the traditional drop of water wearing down resistance—that the anti-metric interests have not been sufficiently active in pushing the opposite side of the question. It appears necessary that the organization of the anti-metric campaign be made more effective than it is."

The Machine-building Industries

THE professional forecasters continue to prophesy, but their utterances, like those of the oracle of Delphi, are so guarded that after the event, no matter what turn things may take, the forecasters can say "I told you so." This is a difficult time for prophets. There is nothing in the industrial situation, considered by itself, to justify or fear apprehension, but it is a fact, nevertheless, that so many business men accept, without question, the belief that a presidential election year of necessity causes bad times, that the mental attitude alone has a serious effect on business. While it is impossible to indicate with certainty what the probable course of business will be during the remainder of the year, a record of the performance of business during the past months will give a picture of the general industrial status from which everyone must draw his own conclusions.

General Review of Business Conditions

March is the last month for which complete statistics are available. Based upon the 1913 average as 100, the pig iron production rose from 120 in February to 134 in March, this production being only 3 per cent below that of a year ago, which was the highest production for the month of March ever attained. Steel ingot production rose in March to the highest level that it has ever reached. It was 64 per cent above the 1913 average, 10 per cent above the previous month, and 2½ per cent above the production for the same period last year, which constituted record production up to that time. Since April 1 there has been a general reduction in both pig iron and steel output, because of reduced sales. Apart from the iron and steel industry, there was a decline of 3 per cent in March in the production of basic industries, the decreases being particularly marked in cotton manufacturing and in the production of bituminous coal and copper. Employment, however, was as general during the month as formerly, but a curtailment in working hours was evidenced by a decline of 2 per cent in average weekly earnings.

The Federal Reserve Bank has devised a standard of comparison by which the production in any one field may be compared with its general trend during recent years. In other words, a "normal" for the present time has been established by taking past averages and the normal increase in business into account. On the basis of this business barometer, iron and steel production was from 5 to 14 per cent above normal in March and passenger automobile production was 38 per cent above normal.

At the present time, unfilled orders on the books of the steel mills are reduced, due largely to the fact that the industry is catching up with its unfilled orders, the March production being a record-breaker. As a result, several blast furnaces have been blown out and some sheet mills have been closed down. Railway freight traffic has fallen below its record-breaking peak of a year ago, due largely to decreases in coal shipments. As one of the serious aspects in the situation, *Commerce and Finance* points out that "real estate speculation in urban centers has gone to a point undreamed of three years ago, and rents, despite the general lower price level, are much higher, subtracting from business profits and public buying power alike. Is it not discernible that this is the sponge that soaks up the national prosperity and is a powerful influence in bringing about recurring seasons of depressions overlooked by the economists?"

The monthly business review of the Federal Reserve Bank of Cleveland, always remarkably clear in its analysis, states that in spite of the fact that "recent information indicates that there has been some curtailment, production is still at a high level, compared with any year except 1923."

The Machine Tool Industry

Even a slight curtailment in general industrial activities reacts immediately upon the machine tool industry, and the demand for new equipment falls off. Nevertheless, we find that machine tool builders who either have an unusually good reputation for their product or who have brought out machines embodying features of special value for increased production, keep their plants reasonably well occupied, except where these plants were so greatly enlarged during the war period that only an abnormal volume of business can keep them occupied. The most serious problem of the industry is this over-capacity of the plants.

In the tool and special equipment field the conditions are considerably better, many of the tool shops in the middle-western states being occupied to capacity, and looking forward to a good business for several months to come, at least. The small tool industry has noticed the falling off in orders from the automobile field, due not altogether to curtailment in production of automobiles—because in percentage figures this curtailment has not been great—but rather to the fact that orders for tools are not being placed for future requirements but only for immediate needs.

The Automobile Industry

A great deal has been published to indicate the serious reduction in the production of automobiles. An examination of the production figures do not bear out the pessimistic statements often heard. The total production of passenger cars and trucks reached 315,000 in January, 366,000 in February, and 381,000 in March, the highest figure ever attained except in May last year. It is not surprising, then, that there should be a decline of about 12 per cent in April as compared with March, the total April production being estimated at 337,000 cars and trucks, or at a rate which, if continued throughout the year, would amount to an output of considerably over 4,000,000 cars.

Every observer of the automobile industry and its market realized long ago that the rate of production could not continue to grow as rapidly as in the past, and that when the industry entered upon a period of stability, with a practically saturated market, its main business would be replacements, and this would never warrant a production year after year like that of 1923, which probably will mark the peak production of the industry for many years to come. But the automobile industry, when ultimately adjusted to its stable market, will become one of the steadiest industries of the country. The industry manufactures a product that is almost as much of a necessity to the American people as food and clothing, and it will continue to be as it is today—one of the greatest outlets for the products of the machine and tool building industries. Competition in the automobile field will necessitate constantly improved methods of production, and the strenuous service demanded of the machine equipment in automobile plants will require constant replacements.

Continued general employment, good wages in most industries, a well sustained but not extravagant consumption of goods, an unusual activity in home building, and a steady growth in savings deposits are factors that may well be balanced in the mind of the thoughtful business executive against the uncertainty of the political situation and the unfortunate lack of ability to work together for the best interest of the nation evidenced at Washington. It is not too optimistic to assume that the favorable influences in industry will outweigh the effect of the political maladjustments.

The British Metal-working Industries

From MACHINERY's Special Correspondent

London, May 14

THE conditions in the British metal-working industries have altered little during the past month. In the Midlands and Manchester areas there is some evidence that the recently noted improvement has been accentuated, while in other centers the improvement is maintained, and nowhere are there any definite signs of setback.

The Machine Tool Industry

There are no cases in which a large influx of orders is reported in the machine tool industry, but business shows fairly steady progress; at the same time, there is a growing tendency to advance prices. In some cases well-known makers have announced an increase of 10 per cent in the price of standard productions to take effect during this month. Another well-known firm states that for the first three months of this year business has been about 10 per cent better than the corresponding period of last year which was considerably better, in turn, than the previous year. Taking all reports into consideration, it would appear that this estimate of 10 per cent improvement fairly represents present conditions in the machine tool industry.

Turret lathes and screw machines are finding a ready market, and upright drilling machines have been in fair demand. Builders of radial drilling machines are moderately well off for orders, and power press makers are also handling a fair amount of new business.

Small tool manufacturers report much the same conditions as machine tool makers, except that the former have a comparatively larger volume of work actually in hand. In several instances, substantial orders are being handled, one works being exceedingly busy on large rotary gear-cutters and hobs, as well as on a quantity of special form milling cutters for machining stainless steel turbine blades intended for use in the propulsion machinery of new naval vessels. Manufacturers of twist drills, taps, and reamers have cut prices substantially, and while more business is being done it is not very profitable.

Overseas Trade in Machine Tools

The official returns for the export of machine tools during March represented that month as the worst since July, 1922, which was the worst month since the war. However, the monthly returns should not be considered singly, as several factors, such as boat departures, arrivals, loadings, and unloadings may give disproportionate figures for individual months. At the same time there has been practically a steady fall in the exports of machine tools since last October, and any improvement in the industry is, therefore, very largely due to an expansion of the home market.

The total value of the exports for March was £84,245 for a tonnage of 762, these figures comparing unfavorably with £125,565 and 1179 tons, the average monthly figures for 1923. The export value per ton during March was £111. The imports of machine tools during March reached a value of £43,532 for 281 tons, the value per ton being £154. The average monthly import value during 1923 was £41,654.

It is interesting to note the respective average values per ton of exported and imported machine tools. For March exported drilling machines had a value per ton of £126, while imported machines were £278 per ton. On the other hand, both imported and exported grinding machines had an average value of about £146 per ton, while imported milling machines showed a value of only £83 per ton, as against £145 per ton for exported machines.

The Automobile Industry

The automobile industry continues to be the brightest branch of the engineering industries. The exceptional activity in this line has been brought about largely by a sense of market security that has been fostered by the import duty of 33 1/3 per cent on foreign automobiles. The notification that the present Government proposes to abandon these duties in less than three months' time is causing some consternation, and if carried out, is likely to have disastrous results.

It is pointed out that apart from any question of industrial protection the effect of the duties, as far as the public is concerned, has been to make heavy price reductions possible. However, it is expected that the real necessity of a retention of these duties will result in sufficient pressure being brought to bear to cause Parliament to reject or at least delay the proposal for abandonment.

The motorcycle trade is also experiencing an abnormal demand. Many of the leading firms have thousands of machines to deliver in the next few weeks, and a special feature of the demand is the prominence of Continental and overseas buyers.

The General Engineering Field

In the engineering industries generally, business is steady, and though little improvement has been shown during the past month the position reached in March has, on the whole, been maintained. Locomotive builders have enough work on hand for foreign and colonial railways to keep them occupied for a few months. Car builders report a lull in new orders, but most of them have enough work on hand to keep them busy for some months. The North British Locomotive Co., Ltd., Glasgow, is exhibiting at the British Empire Exhibition an interesting development in a turbine-driven locomotive. The drive is through double reduction gearing, and it is estimated that a 50 per cent saving in fuel and water is effected over the ordinary type of locomotive. The turbines are of the two-stage type, and the absence of reciprocating parts is expected to reduce considerably the wear and tear of the track and track-carrying structures.

Makers of heavy oil engines of the semi-Diesel type are fairly busy, but steam engine builders, although they have received some important inquiries, do not find that these materialize into orders. Boiler plant manufacturers remain quiet, but makers of mechanical stokers are busier than for some time past. Cranemakers are well occupied, especially with small cranes up to about 5 tons' capacity. The conditions in structural engineering amount almost to a boom, as there is still a good way to go before the five years arrears in essential constructional work, due to the war, will be made up. Heavy electrical engineering is still one of the busiest sections of industry, and an increasing number of inquiries are being received for turbo-alternators and other generating equipment for India and Australia.

Shipbuilding

Recently there has been considerably increased activity in the Clyde shipbuilding yards, and there is now more work in hand than there has been for the last twelve months. There are 140 vessels of a total tonnage of 600,000 gross under construction, but this is still much below the average level of pre-war building. The vessels in hand include over a score of oil-engine ships with an aggregate tonnage of 120,000.

SPRING MEETING OF THE A. S. M. E.

The spring meeting of the American Society of Mechanical Engineers was held May 26 to 29, in Cleveland, Ohio. As usual, a great number of separate sessions were held, each offering something of special interest to engineers engaged in specialized fields of engineering endeavor. Among the different subjects that received attention at these sessions were machine shop practice, tooling and gaging for interchangeable manufacture, windmill and fan design, management, power problems of the steel industry, recent developments in heavy electric locomotives, influence on materials of high and low temperatures, general machine design, and aeronautics and ordnance.

At the machine shop session, papers were read by W. E. Sykes on "British Machine Tool Design"; by A. B. Cox, on "Limiting Cases in Involute Spur Gearing"; and by R. H. Rausch on "The Sine Bar as a Universal Planing Gage." The session relating to tooling and gaging for interchangeable manufacture featured two papers, one by A. L. DeLeeuw on "Analysis of a Machine Shop Problem on a Quantity and Final Economy Basis," and one by Major Earl McFarland, on "Interchangeable Manufacture of U. S. Army Rifle Bolt."

British Machine Tool Design

In his paper on British machine tool design, Mr. Sykes showed the present status of the British machine tool industry by representative examples from current practice. No attempt was made to compare British machine tools with those designed and made in this country. The paper was devoted mainly to a general description, with illustrations, of recent developments in British machine tool practice, the author pointing out that there is a fair number of British machine tools of recent design that are well worthy of careful study by all who are engaged in the metal-working industries.

Among the machines shown were engine lathes; turret lathes; automatic lathes; boring mills; radial drilling machines of the plain and universal type; planers, both of the standard and side-planing type; milling machines; horizontal boring machines; and grinding machines. The author stated that a study of present British designs shows the following tendencies toward improvements: (1) Ease of operation without reducing either strength or rigidity; (2) greater accuracy, both initial and permanent; (3) the use of higher quality materials; (4) elimination of belts and countershafts; (5) more efficient and additional safety devices; (6) automatic lubrication and the elimination of oil and grease cups; (7) development of automatic mechanisms; and (8) better finish and neater appearance.

Limiting Cases in Involute Spur Gearing

In his paper on involute spur gearing, Mr. Cox gave formulas by means of which it is possible to determine the smallest number of teeth that an involute spur gear can have and yet be a perfect gear. By a "perfect" involute gear is meant a gear with teeth formed by straight, non-under-cut flanks and unmodified involute faces, which is capable of rotating in either direction, during which rotation at least one tooth of the driving gear will always be in contact with a tooth of the driven gear, so that the rotation of the driven gear will be continuous and uniform.

The Sine Bar as a Universal Planing Gage

In his paper on the sine bar, Mr. Rausch gave the details of an accurate system of gaging used when large pieces are machined at comparatively long intervals, and showed how the sine bar may be used as a templet for setting planer heads and tools, giving complete formulas for use in connection with this work. This system has been developed at the Pond plant at Plainfield, N. J., of the Niles-Bement-Pond Co., where the author is shop superintendent. At this plant, large machine tools are built where the gages for the large machines are used only at comparatively long intervals.

Determining Economical Methods of Machining

A. L. DeLeeuw, in his paper relating to the analysis of machine shop problems from an economic point of view, discussed the methods that should be followed in determining the most economical method of machining work, either in large or small quantities, all other items being excluded except those that relate to the actual machining processes. Attention was called especially to the difference between the saving of labor cost and the ultimate economy. As a concrete example, illustrating the methods of some of the operations, an automobile connecting-rod was used. The author stressed the point that the best machine shop methods are those that give the highest ultimate economy under the existing conditions, and emphasized that it is the ultimate economy that counts and not the economy of a single operation, and that some methods may be good under one set of conditions but objectionable, or at least less desirable, under another. For example, the most economical way of turning a piece when it is to be ground afterward is not necessarily the best method when the piece is to be finish-turned in a lathe. Again, what is the best method of machining when a steady stream of work passes through a factory, may not be the best method when the work comes through only at intervals.

Among the outstanding papers of the session should be mentioned the one prepared by W. L. R. Emmet and L. A. Sheldon of the General Electric Co. on the Emmet mercury-vapor process, describing the methods used in increasing the efficiency of steam power plants by means of mercury boilers, one of the most recent and epoch-making developments in the power plant field.

Complete copies of the papers read before the meeting may be obtained by addressing the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

* * *

SUMMER MEETING OF S. A. E.

At the summer meeting of the Society of Automotive Engineers to be held at Spring Lake, N. J., June 24 to 27, four subjects of current interest in the automotive field will be dealt with at the technical sessions; these are, crankcase-oil dilution, air-cleaners, new developments in transmissions, and riding quality. The discussion in the riding-quality session is intended to concentrate engineering thought on this important phase of passenger car improvement. There will be a paper on spring design by S. P. Hess. Professor E. H. Lockwood of Yale University will describe some of the tests made and conclusions reached in the university's investigations of factors affecting riding quality. J. A. C. Warner of the society's research staff will tell what some of the other investigators of riding quality have accomplished.

While it is difficult to find a solution for the problem, it is known that the motoring public does not like to shift gears. Some other means of torque conversion than the sliding-gear transmission may eventually be generally used. G. W. Cate, W. A. McCarroll and a representative of the Weiss Engineering Association will describe new and interesting transmission mechanisms in the transmission session. Professor J. M. Nickelsen of the University of Michigan will present a summary of what has been done in this field and discuss the promise of new transmissions in the future.

* * *

A conference on the standardization of cast-iron pipe will be held in the rooms of the American Society of Mechanical Engineers, 29 W. 39th St., New York City, Thursday, June 5, at 10:30 A. M. (daylight saving time). This conference has been called by the American Engineering Standards Committee, in order to take action upon the standardization of cast-iron pipe. Those interested in this subject either as manufacturers of pipe, users of pipe, or engineers are invited to attend.

Design of Magazine Attachments

By ALBERT A. DOWD

THERE is no more fertile field for the designer than that of special and automatic machinery. It is not only extremely interesting but profitable as well, because the demand for draftsmen experienced along this line is far ahead of the supply. In mechanical work, more and more, operations are performed automatically, while in handling, counting, weighing, folding, packing, and tieing operations, the field is constantly growing. Years ago any product was designed for the purpose for which it was to be used without giving much consideration to the manufacture. At present, however, methods of manufacture and the possibilities of using automatic machinery are also considered, and they influence the design to a great extent. Upon the cost of manufacture depends, to an appreciable degree, the market price of the commodity; therefore in competition with other goods of a similar kind, the production cost is a prominent factor.

The designer of automatic machines has all sorts of problems presented to him, and often no two are alike. Frequently there is no precedent to serve as a guide, which makes the problem more difficult. There are many varieties of automatic machines, and there are almost always several ways in which a mechanical problem can be solved. A fertile brain, combined with wide experience and the gift of analyzing any proposition from all angles in a broad-minded way, are essential factors in successful automatic machine design. Naturally, the first step in the design of any kind of automatic machine is a careful consideration of the product to be made or handled; its shape, structure, operations required to make it, etc. Economy of material is important, whether the product be made from raw stock or from previously fabricated materials. The likelihood of changes in the product is always present, and for this reason machines should be made as flexible as possible, when this does not entail complications in design.

In automatic screw machines that handle bar stock, the stock is fed forward, all the cutting operations are performed, and the finished piece is ejected automatically. Certain other types of machines handle short bar work from a magazine, chucking it or holding it on previously machined centers. Milling machines of the automatic type are made in several varieties, and numerous other kinds of machines have more or less automatic features. In practically all types the most difficult problem is that of feeding, locating, and holding the work, particularly when it consists of small

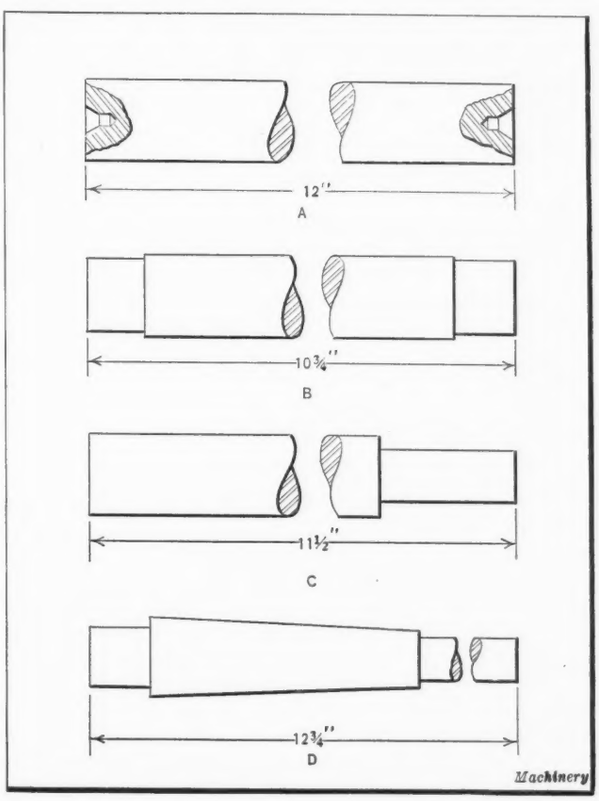


Fig. 1. Bar Stock for which Feeding Magazines are to be built

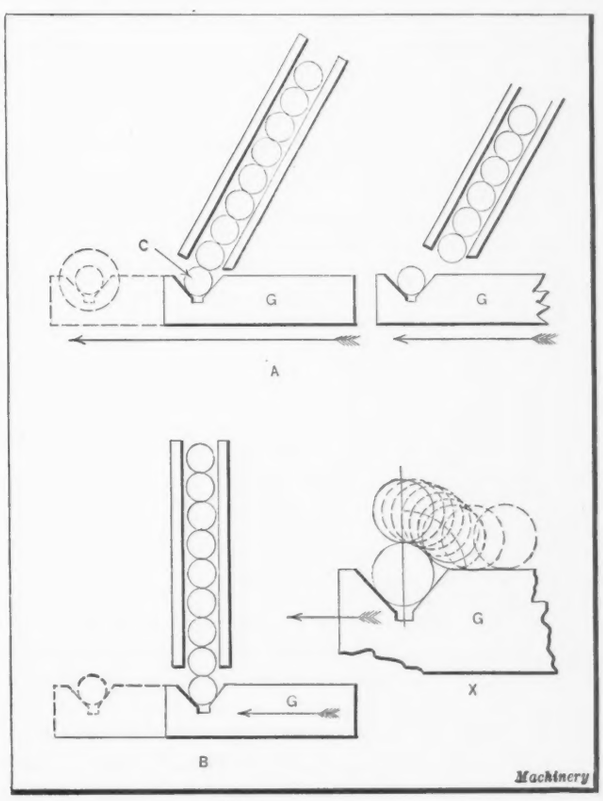


Fig. 2. Inclined and Vertical Chute Magazines for feeding Bar Stock

or short pieces. Hence, it is of great importance that the designer pay particular attention to these factors.

In designing any magazine attachment, the first problem is the arrangement of the pieces to be handled; next, the removal one at a time from the magazine; and finally the locating and securing of the work in its proper position, ready for machining. Provision must also be made for ejecting the work into a receptacle from which it can be easily removed. A great deal depends upon the shape of the work and its condition. Pieces of regular shape are not generally difficult to handle, but those having irregularities or projections are likely to cause trouble. If the work can be stacked one piece on top of another, a gravity feed is generally used, although in many cases a hopper may be required into which the pieces are dumped in a mass. With a hopper, the pieces must be so separated and arranged that they will come to the magazine in a uniform manner which permits handling without complications.

As an example, assume that it is required to design a magazine for feeding the short bar of stock shown at *A* in Fig. 1. This piece is of uniform diameter throughout and has previously been centered at both ends ready for locating on lathe centers. Fig. 2 shows two methods of feeding, the one at *A* holding the pieces on an inclined plane between guides, while that at *B* holds them in a vertical column. At *A* the pieces roll down the incline by gravity, and the lowest one *C* rests in a vee in carrier *G*, as shown at the left. The carrier moves forward to carry the work, as indicated by the dotted lines, to the centers on which it is to be held while turning. During this forward movement the next piece in the magazine drops down and rests on the carrier, as shown at the right.

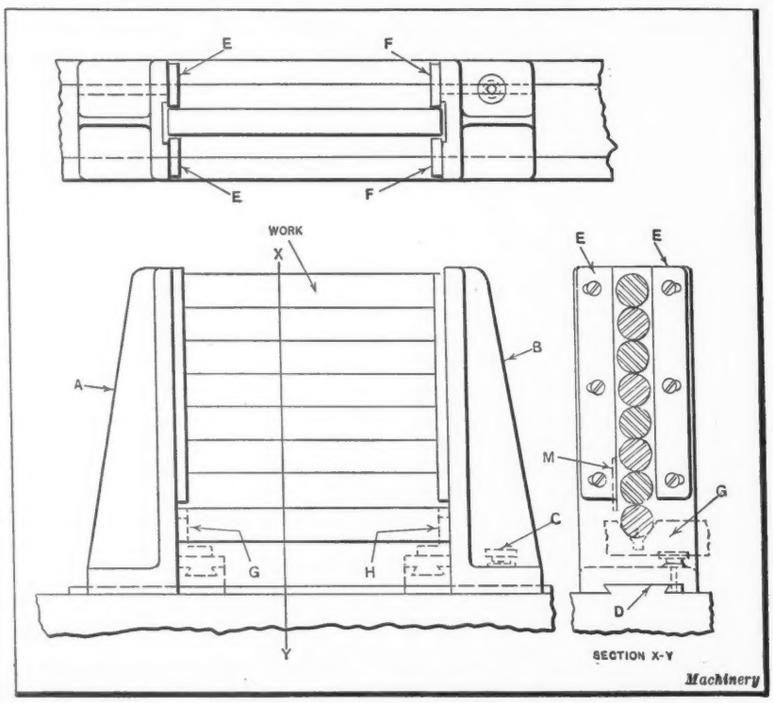


Fig. 3. Magazine Attachment in which Adjustments have not been considered sufficiently

The difference between the vertical and the inclined chutes, from the standpoint of operation, is in favor of the vertical type, because right-angle construction is more simple than angular, and less likely to cause trouble. There are, of course, two carriers for handling this kind of work, and there is usually a means of adjusting the vee for different diameters of shafts. The carriers are coupled in such a way that they operate simultaneously, yet at the same time they must be capable of longitudinal adjustment as the chutes are moved closer together or further apart. The enlarged detail at *X* illustrates the rolling action of the second piece of stock on top of the first which is being carried forward into position by the carrier.

Details of a Bar Stock Magazine

It is evident that when a machine is to handle bar stock of short lengths on which both the diameters and lengths vary on different jobs, the magazine must be adjustable not only for length but for diameter. Fig. 3 shows the general details of construction of a simple form of magazine for this class of work. The column *A* may be fixed or adjustable, while that at *B* is always adjustable. As both columns fit the dovetail *D*, convenience and adaptability may make it advisable to so design each of them that they can be moved longitudinally and set where desired. Screw *C* is used to draw up on an angular gib as shown, and thus lock the column in any position. By this means adjustments for different lengths of stock can be made without difficulty. The carriers, which are shown by dotted lines at *G* and *H*, must be so arranged that they also can be moved longitudinally. Plates *E* and *F* on the faces of the columns can be moved toward or away from each other as required for different diameters of stock, but they cannot be adjusted vertically.

In general, this magazine design is acceptable, yet the details of construction have not been well thought out, and the flexibility is not great enough to handle a large variety of work. For example, if bars much smaller in diameter than those shown, are to be used, plates *E* and *F* would be too far above the carrier, and so a second piece might drop down into the vee of the carrier and follow along with the first, thus causing considerable trouble. This could, of course, be obviated by placing a sheet-steel guard at *M*, which could be adjustable vertically to suit different diameters. For a comparatively cheap design such an arrangement might be permissible, but it would not be considered good practice in a well designed machine. Also, the slotted holes in plates *E* and *F* could be enlarged to allow for vertical as well as horizontal adjustment, in which case large washers under each screw-head would be necessary to allow for the extra movement of the plates. Such points as these should be considered in the design.

One of the greatest drawbacks to many otherwise well designed automatic machines or attachments is the fact that they are not sufficiently adaptable to take care of changes in the product, so that when such a contingency occurs some "makeshift" arrangement must be devised. There are many cases where a lack of flexibility necessitates considerable redesigning, with the attendant costs. Yet on the other hand, too much flexibility in design is expensive and a happy medium should always be sought.

A Preferable Design

In Fig. 4 a much better design is shown, although the general idea is much the same as in the previous example. Only one side of the magazine is illustrated, but the other is exactly like it. Column *B* is an iron casting dovetailed at *C* to permit longitudinal adjustment along the machine bed. Two screws are provided for locking binder gib *D* at any desired point. Plates *F* and *G* are slotted so that they can be easily adjusted for work of different diameters by loosening screws *H*. Both plates are attached to slide *K*, which can be moved up or down in a groove in casting *B*. The slide is locked in position by tightening screws *M* at the back of the column. The web of the column is slotted to allow for the necessary movement of the screws. For

large diameters of work, plates *F* and *G* would be separated as shown by dimension *N*, while for smaller diameters they would be closer together, as indicated at *O*. In order to keep the clearances under the magazine as they should be, the slide can be moved down a distance *Q* for the small diameter.

The advantages of a construction like this will be evident by referring again to the examples shown in Fig. 1. The straight shaft *A* is a piece of cold-rolled steel of one diameter, so it does not require any special setting of the plates. However, example *B* has been turned down at both ends, and the plates must be adjusted so that these finished surfaces will slide easily between them. The vertical adjustment must also be made from these finished ends. In example *C*, which is a piece of machine steel sometimes known as "black stock," only one end has been partly finished. Hence the plates on one column must be adjusted both horizontally and vertically for one diameter, and the vees of the carrier must also be adjusted. At the small end the vertical slide must be set down further to keep the pieces in alignment. In the last example *D*, the work is of different diameters at both ends and tapered besides. When pieces of this kind are arranged one over the other in a chute they will not lie horizontally, as the large diameters at one end will naturally make that side of the pile higher than the other. However, this fact does not interfere with picking up the pieces if the plates are adjusted in both directions as they should be. With the previous form of chute it would be difficult to so arrange the plates that the pieces would fall into the carrier in good order.

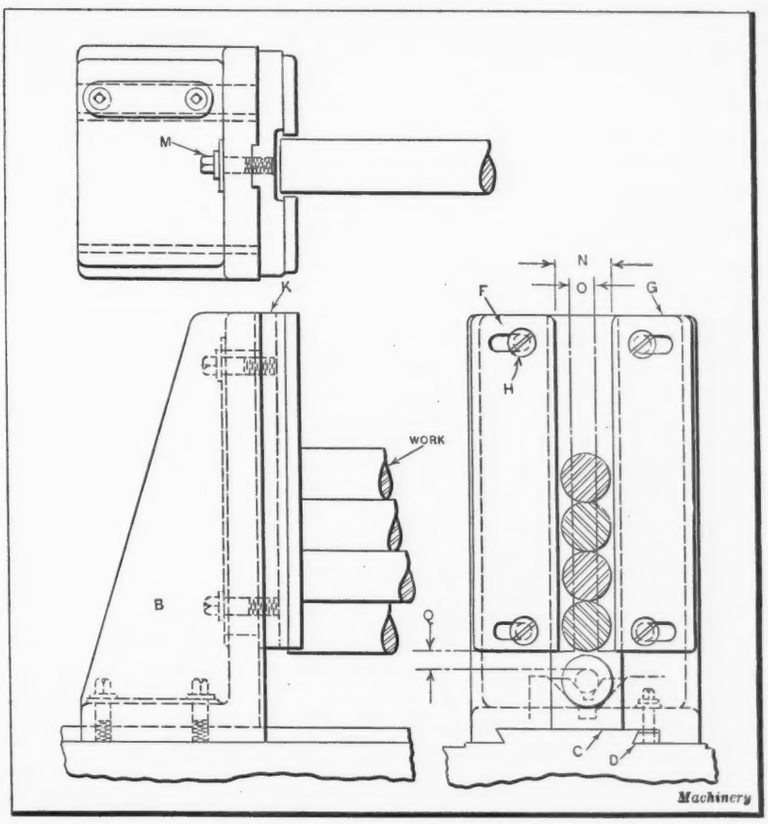


Fig. 4. Improved Magazine Design which accommodates a Large Variety of Work

Nearly all magazines for short bar work are arranged very much on the principles here given, and the adjustments are usually sufficient to handle forgings of uniform size. The designer should consider carefully the possibilities of the machine and the likelihood of handling other work on it by using the same attachments. There is often a different method of mounting the chutes in relation to the machine or to each other, but this is obviously dependent upon the type of machine and the general requirements. A similar arrangement is used when short pieces are to be fed into a hollow spindle and afterward pushed through it to the chucking position.

* * *

The machine builder serves society by multiplying muscle power through the transfer of skill and intelligence from men to machines. To obtain commensurate reward for this service, machine builders must apply at least as much thought to solving the problems of the balance sheet as they do to solving the problems of the drawing board.—*The Buckeye Philosopher*

SYSTEM FOR MAKING CHANGES IN DRAWINGS

By H. A. FREEMAN

A machine is rarely designed which is not subsequently altered in various ways, either to correct errors or to facilitate production. Many of these changes are, however, of minor importance and can well be withheld from the shop until the machine has been carefully tested and a set of blueprints made up embodying all, or a large number, of the changes that the tests show to be advisable. This method eliminates the confusion in the shop that is sure to follow a succession of small changes with their attendant retardation of production and outlay in material and labor involved in calling in old blueprints and issuing new ones. In some cases it may be necessary, however, to make changes in a part as soon as the change is approved. In order to simplify the work of providing the shop with up-to-date blueprints under such conditions, a certain manufacturer adopted the method described in the following.

In one corner of each tracing, a space about 1½ by 3 inches is blocked out with ink on the back side of the tracing. As soon as minor changes are approved by the chief engineer, a description of the change is written in pencil on the blocked out space on the front side of the tracing by the chief draftsman. When the man in charge of the blueprint room receives an order for a print, he scrutinizes the "change block," as it is called, and if nothing appears thereon the tracing is sent directly to the blueprint machine. If pencil notations appear on the "change block," the tracing and blueprint requisition are referred to the chief draftsman, who either has the drawing revised and returned to the blueprint room or else returns the tracing and the approved blueprint requisition to the blueprint room. By this means the tracing serves as a record of all changes recommended and approved, but it can be used in making blueprints of the original design until the authorization of a new shop blueprint with the required changes.

In making a revision, the tracer copies the exact wording found in the "change block" on the margin of the drawing, and makes the necessary alteration in the body of the drawing, leaving the writing in the "change block" undisturbed until the checker, chief draftsman, and chief engineer have initialed the change. The pencil notes for the changes are then washed from the face of the tracing with benzine, and the tracing is delivered to the blueprint room. In the plant where the method described has been adopted, the expense for blueprint paper alone has been reduced more than 25 per cent, and this system has made it unnecessary to expand the blueprint department, which was considered an urgent necessity before the adoption of the new method.

TIN FOIL

Tin foil consists of a thin sheet of lead with a very thin coating of tin on each side. It is used extensively for wrapping food products, candies, tobacco, and various other articles of commerce. Briefly described, it is made in the following manner: First a tin pipe is made of such proportions as to give, in subsequent processes, the required relative thickness between the tin coating and the covered lead sheet. This pipe is then filled with molten lead, and, after cooling, rolled or beaten to the extreme thinness required. In this process, the tin coating spreads simultaneously with the spreading of the lead core and continuously maintains a thin even coating of tin on each side of the center sheet of lead. It is possible in this manner to reduce the thinness of the lead sheet to one-thousandth inch or less, and still retain an uninterrupted tin coating.

CONCRETE MIXTURES

Concrete consists of a mixture of sand, gravel, or broken stone, and cement in various proportions. Water is added to this, which, when chemically combined with the cement, binds the whole mixture together into a solid mass having the characteristics of strong artificial stone. The amount of each ingredient is usually measured by volume, and the mixture is generally designated by stating the proportion of each ingredient in a given order, as "1:2:5," where the first figure indicates the proportion, by volume, of cement; the second, the proportion of sand; and the third, the proportion of stone or gravel; hence, 1:2:5 concrete contains one barrel of cement (usually Portland cement), two barrels of coarse sand, and five barrels of gravel or broken stone. For water tanks and similar structures which are subjected to considerable pressure and are required to be water-tight, mixtures rich in cement and composed of either 1:1:2 or 1:1½:3 concrete are used. For reinforced floors, beams, columns and arches, as well as for machine foundations that are subjected to vibration, a 1:2:4 concrete is generally used. This composition is also employed when concrete is used under water. For ordinary machine foundations, retaining walls, bridge abutments, and piers in the air, a 1:2½:5 concrete is satisfactory, and for ordinary foundations, heavy walls, etc., a lean mixture of 1:3:6 concrete may be used.

MINERAL WOOL

Mineral wool is a fibrous substance made from blast-furnace slag by sending a blast of steam through the molten slag. This substance, sometimes known as "silicate of cotton," is used as a heat insulator and also as a fireproofing material. In the latter case, it is packed between the wall and floor spaces of fireproof buildings. Mineral wool may also be made by sending a blast of steam through molten rock. This "rock wool" should be used when the heat-insulating material is in contact with metal, as the sulphur in the slag wool is likely to cause corrosion. The best grades have a fine fibrous structure, and are fairly free from lumps. Variations in the character of the slag affect the grade of the wool, and there is usually a difference in the density of the wool at every cast. The method of producing mineral wool is briefly as follows: Blast-furnace slag and coke are charged into a cupola. The molten slag, at the moment when it flows through the slag hole, is then divided into fine threads by streams of steam. These fine threads are blown into a long narrow building, where the material is stored and packed.

EFFICIENCY OF POWER PLANTS

The efficiency of a steam power plant, even when it consists of the best modern equipment, is relatively low. Good boilers impart to the steam, on an average, 70 per cent of the heat of the fuel, or produce, approximately, 10 pounds of steam per pound of good coal used, and less in the case of a poorer grade of coal. Well-designed engines exhausting to the atmosphere use from 30 to 40 pounds of steam per hour per horsepower, so that such boilers and engines working together would require from 3 to 4 pounds of coal per hour per horsepower, and when the power plant is small and the equipment is not of such high grade, the coal consumption may be increased to 6 or 8 pounds. A coal consumption of 3 pounds per hour for each horsepower corresponds to a plant efficiency of about 5.6 per cent, and a coal consumption of 8 pounds, to a plant efficiency of 2.1 per cent. Therefore, non-condensing steam plants equipped with engines of the simple type and burning from 3 to 8 pounds of coal per hour per horsepower are capable of converting into useful work only 5 or 2 per cent of the heat the coal contains. Improvements in equipment and methods of working have increased this value to about 15 per cent in the best modern power plants. This increase in efficiency has been obtained partly by the reduction of heat losses in generating the steam, and the return to the boiler of some of the waste heat.

GERMAN SILVER

German silver, also known as "nickel silver," is an alloy of copper, nickel, and zinc, the best quality consisting of 50 per cent of copper, 25 per cent of nickel, and 25 per cent of zinc. This quality, however, is the most difficult to work, but takes a fine polish and is frequently used for tableware to imitate silver. When the proportion of copper is somewhat higher, the alloy is suitable for rolling and for drawing into wire. German silver is known under probably a greater number of names than any other alloy. In addition to the name "nickel-silver," it is also known as "Chinese white silver" or "packfong," "white copper," "silveroid," "Nevada silver," and "electrum." German silver can be hammered, rolled, stamped, and drawn. At the same time, it possesses the properties of being hard, tough, and not easily corroded, but, when exposed to the air, it tarnishes, becoming slightly yellow. At a heat above dull red, it becomes very brittle. German silver can be readily soldered. The usual composition of German silver solder is: Copper, 47 per cent; nickel, 11 per cent; and zinc, 42 per cent.

WEIGHT OF AIR

Air is a mechanical mixture composed of 78 per cent, by volume, of nitrogen, 21 per cent of oxygen, and 1 per cent of argon. The weight of pure air at 32 degrees F., and an atmospheric pressure of 29.92 inches of mercury or 14.70 pounds per square inch, is 0.08073 pound per cubic foot. The volume of a pound of air at the same temperature and pressure is 12.387 cubic feet. The weight of air, in pounds per cubic foot, at any other temperature or pressure may be determined by first multiplying the barometer reading (atmospheric pressure in inches of mercury) by 1.325 and then dividing the product by the absolute temperature in degrees F. The absolute zero from which all temperatures must be derived in dealing with the weight and volume of gases, is assumed to be minus 459.2 degrees F. Hence, to obtain the absolute temperature, add to the temperature observed on a regular Fahrenheit thermometer the value 459.2.

ACID-PROOF TANK LINING

A lining for protecting tanks from the influence of acids is made from a mixture consisting of 75 parts (by weight) of pitch; 9 parts of plaster-of-paris; 9 parts of ochre; 15 parts of beeswax; and 3 parts of litharge. The tanks are covered on the inside with a thick coat of this mixture.

SURFACE COMBUSTION

If a mixture of gas and air, which is being emitted at a high velocity from a Bunsen burner, is permitted to strike against a piece of red-hot firebrick held a short distance away from the front of the burner, the mixture will burn at the surface of the firebrick. This constitutes the principle from which the methods of what is called *surface combustion* have been developed. In the practical application of surface combustion, an explosive mixture of gas and air in the proper proportions for complete combustion, or with air in slight excess, is caused to burn without flame in contact with a granular incandescent solid, whereby a large proportion of the potential energy of the gas is immediately converted into radiant form. The principle is the same as having a multitude of small burners instead of one or a few large burners. The advantages claimed for the system are that the combustion is greatly accelerated by the incandescent surface, and can be concentrated just where the heat is required; the combustion is perfect with a minimum excess of air; the attainment of very high temperatures is possible; and owing to the large amount of radiant energy developed, the transmission of heat to the object to be heated is very rapid. Boilers arranged for surface combustion have a mixing chamber in front of the tubes and connecting with them. The tubes contain the granular refractory material. The gas mixture is forced through the tubes at a high velocity, and complete combustion is insured after the gas has traversed a very short distance. The remainder of the granular material in the tubes acts as a baffle for the hot gases, forcing them toward the walls of the tubes in order that a large proportion of the heat may be given over to the water. Surface combustion fires can be run efficiently at temperatures in excess of 3000 degrees F. It is possible to consume efficiently a volume of gas equivalent in heating power to 150 pounds of coal per hour per square foot of fuel bed while not more than from 60 to 70 pounds per square foot of grate area can be burned on locomotive boiler grates. This intensity of fuel consumption coupled with almost perfect combustion produces an intensely hot radiant fire. There being no excess of air, a minimum of heat is carried off in the waste gases.

TRANSLATING GEARS

When a lathe is to be used for cutting threads in accordance with both the English and metric systems of measurements, what are known as "translating gears" are sometimes used. These gears have 50 and 127 teeth, respectively, these numbers representing the relation between the English and metric systems of measurement; thus, 1 inch is equivalent to 2.54 centimeters, and $\frac{1 \times 50}{2.54 \times 50} = \frac{50}{127}$. By inserting these gears in the train of gearing connecting the lathe spindle and the lead-screw, it is possible to gear the lathe for cutting a given number of threads per centimeter, the translating gears being used in addition to the same gears that would be employed for cutting a similar number of threads per inch.

VALVE-SETTING MACHINE

In connection with locomotive valve setting, it is necessary repeatedly to place the main driving wheels at the dead-center positions. There are three general methods of securing the necessary motion of the driving wheels for setting valves. The old method was to move the entire locomotive along the track by means of pinch-bars; obviously, this was a slow laborious method. An improved method is to turn only the main driving wheels, which are simply connected with the cross-heads by the main rods (the side-rods being disconnected), and are mounted on rollers which are rotated either by a hand-ratchet lever or by an air motor. There are two rollers under each wheel, and a supporting frame for the rollers, so that the rollers and driving wheels may be readily rotated. This device is sometimes known as a "valve-setting machine."

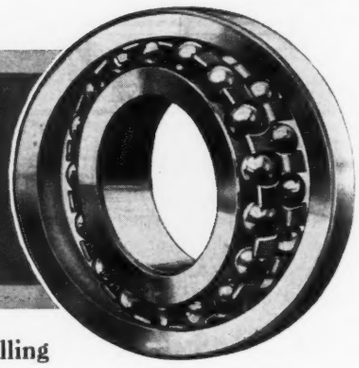
TRANSFORMERS

An electrical transformer, also known as a "static transformer," may be defined as a stationary (not rotary) apparatus for changing alternating currents of a given voltage into current of a higher or lower voltage. The possibility of changing the voltage of the current is of great importance, because, in most cases, the economical voltages for generating, transmitting, and using electric power are all different. Fundamentally, the alternating-current transformer is very simple. If alternating current is passed through a coil called the "*primary*," an alternating magnetic field is set up. If another coil, called the "*secondary*," is placed close to the primary coil, the magnetic field induces in the secondary coil a voltage directly proportional to the number of turns. The product of primary volts times primary amperes is equal to the product of secondary volts times secondary amperes. Thus the kilovolt-amperes in the primary and the kilovolt-amperes in the secondary are equal, except for small losses in the apparatus. In very small transformers, the heat due to the internal losses is dissipated without undue rise of temperature, and no special provision need be made for it. In medium- and large-sized units, some special arrangement must be made to dissipate the heat without too great a rise of temperature. With reference to the method of cooling, transformers of considerable size are classified as oil-cooled, water-cooled, and air-blast.

WAX COATING FOR ETCHING

In using the chemical etching process for etching names or designs on steel, etc., the proper application of the ground which is used to protect the parts from the action of the corroding fluid is very important. Some form of wax on which etching fluid has no action is generally used for this purpose. For general purposes, beeswax of the proper consistency is excellent, and it can be applied easily in any desired thickness. Before applying the wax, it is important that the surface be thoroughly clean and absolutely dry, and the difference in temperature between the wax and the article to be etched should be slight. If it is necessary to dip the piece into melted wax, the article should be kept immersed for a few moments until it acquires the same temperature as the molten wax. If there is a film of oil on the surface to be coated, the wax will cover it but not adhere, and in consequence the etching fluid will run under the wax and produce a smear or blur. The same effect is produced by moisture, except that in this case the blur is likely to be worse, as there is an affinity between water and etching fluid which causes spreading.

Application of Ball Bearings to Machine Tools



Method of Applying Ball Bearings to Lathes, Grinding Machines, Drilling Machine Spindles, and Transmission Shafts

THE variety of styles, types, and sizes of ball bearings now on the market is so complete that it is possible to obtain suitable bearings of this kind for almost any shaft, spindle, or rotating part that may be incorporated in a machine tool. In selecting a ball bearing for any revolving part, it is first necessary to determine the speed at which the part will rotate and the load and thrust to which it will be subjected. The method of assembling the part in the machine, the changes of temperature to which it will be subject, the amount of end play allowed, and the possible amount of deflection or misalignment are all factors entering into the selection and method of mounting ball bearings.

Originally ball bearings were developed for the purpose of eliminating friction losses. However, there are other advantages gained by their use that may in some cases be considered of equal importance. Ball bearings can be run at very much higher speeds while carrying much greater loads than even the best types of plain bearings, without danger of heating and seizing. Ball bearings require lubrication only at infrequent intervals—in some cases three or four times a year is sufficient. The bearing length is usually much less than is required for a plain bearing of equal capacity, and this characteristic is sometimes a deciding factor in its favor.

Probably there are many manufacturers who have considered equipping their products with ball bearings, but have hesitated to do so because of the limited experience of their engineers or designers in the application of these bearings. By making a close study of the successful applications of other manufacturers in his own or a similar field, any manufacturer should be convinced that the problem is not such a difficult one, especially when the services of the engineering staffs of the ball bearing manufacturers are available. The ball-bearing lathe, grinding machine, and drilling machine spindles and transmission shafts described and illustrated in this article have proved practical and satisfactory, and are presented here so that designers may use them as guides in the application of ball bearings to machine tools of the same or similar types.

Ball-bearing Lathe Head

In Fig. 1 is shown a lathe head equipped with ball bearings. It will be noted that three different types of ball bearings are used on the lathe spindle. The faceplate end of the spindle is supported by a double-row radial thrust bearing, which is a standard product of the Fafnir Bearing Co., New Britain, Conn., as are also the other bearings shown in this illustration. The double-row bearing, in addition to carrying the radial load also takes a thrust load in either direction. Thus, besides supporting the spindle, this bearing serves to prevent endwise movement. The inner race is seated securely on the spindle and revolves with it. The outer race or ring is made a sucking fit in the housing, so that a gradual creep of the ring is allowed, which results in the ultimate distribution of the maximum load over the entire race. As this bearing is designed to take an end thrust in addition to the radial load, the outer ring is allowed a lateral play between the retaining plates of only 0.01 inch in either direction.

The opposite end of the lathe spindle is mounted in a single-row radial ball bearing having deep grooves which conform closely to the ball curvature and thus afford the balls ample support under the maximum load. The inner race of this bearing is made a light drive fit on the shaft, the same as the inner ring of the bearing at the opposite end of the spindle. The outer race is mounted between retaining plates like the double-row bearing, except that a generous clearance is allowed between the race and the plates. This clearance permits the outer race to have a certain amount of longitudinal movement which compensates for any expansion and contraction of the spindle that may result from changes in temperature. As an added precaution, the inner races of the bearings, which are a light drive fit on the spindle, are securely held in place between spacing members or clamping nuts.

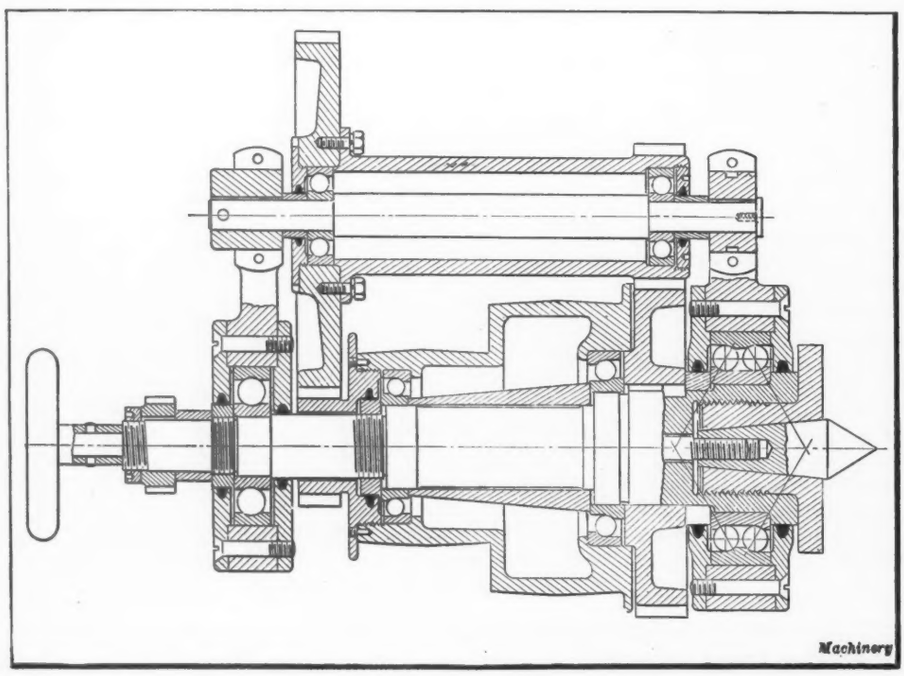


Fig. 1. Lathe Head in which the Spindle, Cone Pulley, and Back-gears are mounted in Ball Bearings

It will be noted that a single-row radial thrust ball bearing is used at each end of the two-step cone pulley. The bearing lo-

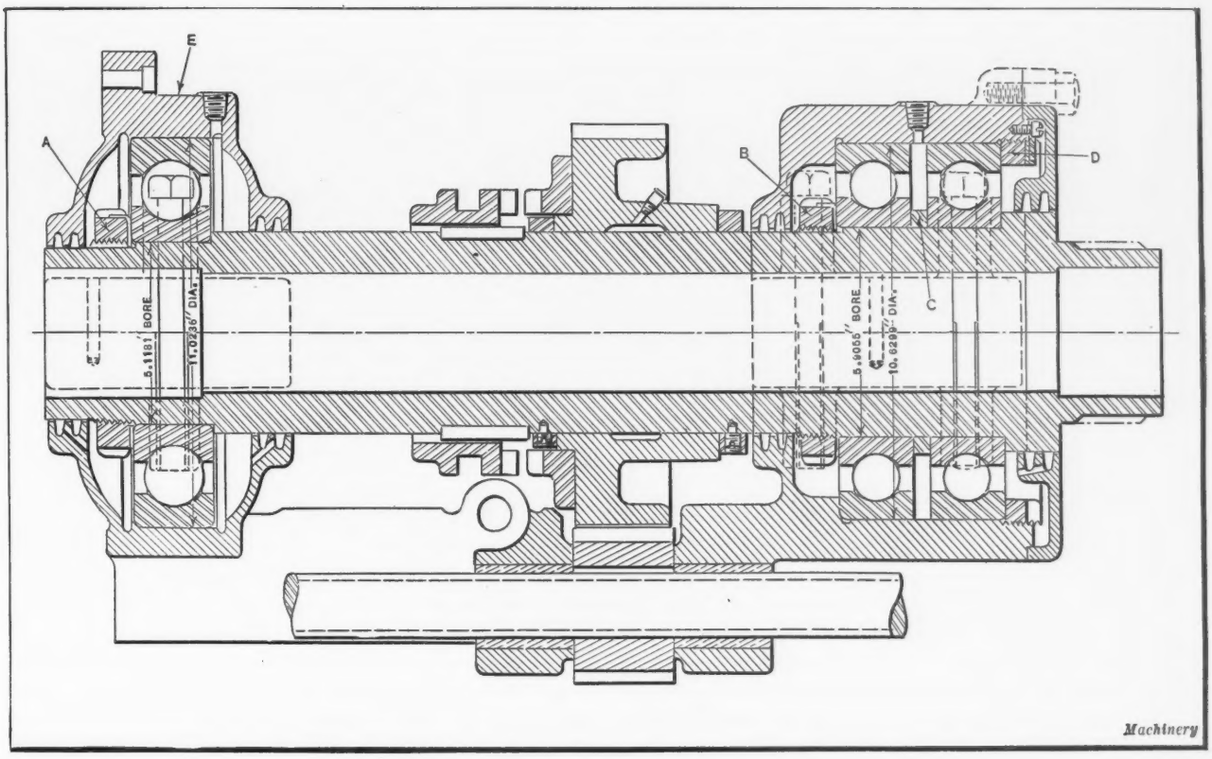


Fig. 2. Turret Lathe Spindle equipped with Ball Bearings

cated at the right-hand end of the cone takes any thrust on the pulley that would tend to force it to the right, while the bearing at the left-hand side takes any thrust in the opposite direction. When the back-gears are not engaged, the cone pulley is clamped to the spindle and revolves with it, but when the back-gears are engaged, the pulley revolves on the bearings, so that a relatively slow spindle speed is obtained through the reduction gearing mounted on the jack-shaft. The jack-shaft is supported by two single-row ball bearings having deep grooves.

Application of Ball Bearings to Turret Lathe Spindles

The turret lathe spindle shown in Fig. 2 is mounted in three SKF ball bearings of the single-row deep-groove type. When assembling this unit, the ball bearings are heated in oil to a temperature of 175 degrees F., and then pressed on the shaft. In addition to the press fit, threaded collars *A* and *B* are employed to clamp the inner races against the shoulders on the spindle. A small spacing ring *C* is placed between the two ball bearings at the head end of the spindle. The outer races of the two bearings at the head end of the spindle are held in place by a clamping ring *D*. In adjusting this ring to eliminate axial play, caution must be exercised to avoid imposing an undue thrust load on the bearings. The outer race of the bearing at the tail end of the spindle is mounted in a split housing *E* with an allowance for axial movement which is necessary to permit the free expansion and contraction of the lathe spindle due to changes in temperature.

This installation is used when some form of chuck is employed. If a tapered center is to be used in the spindle, provision must be made to prevent the shock of driving the

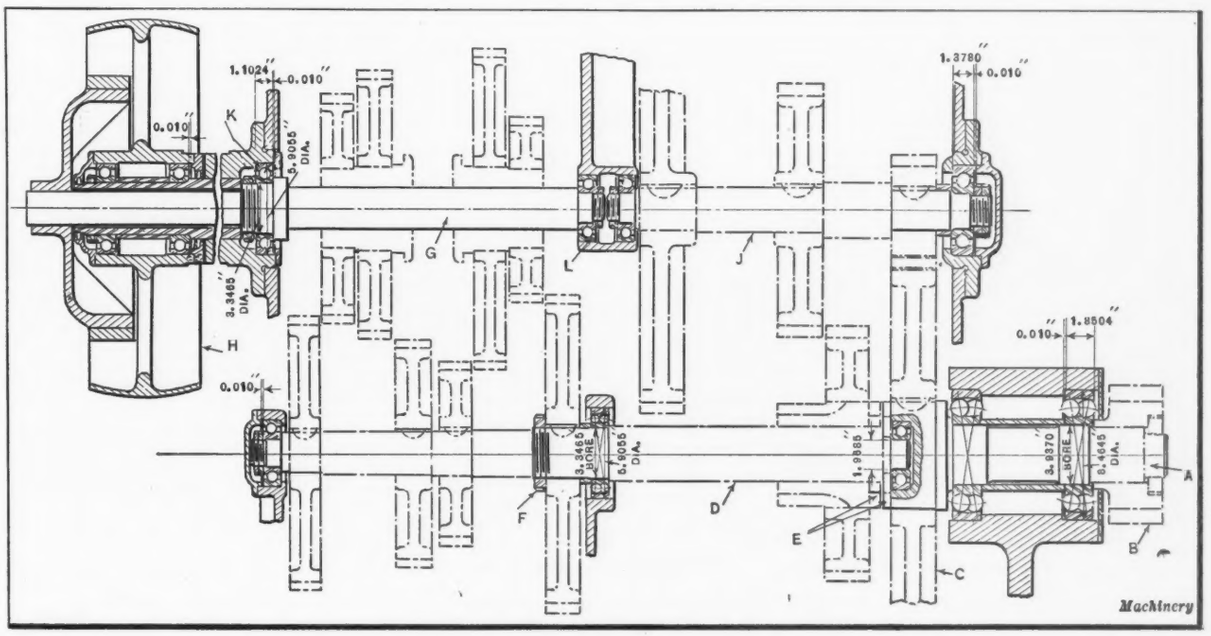


Fig. 3. Ball-bearing Equipped 60-inch Geared Headstock

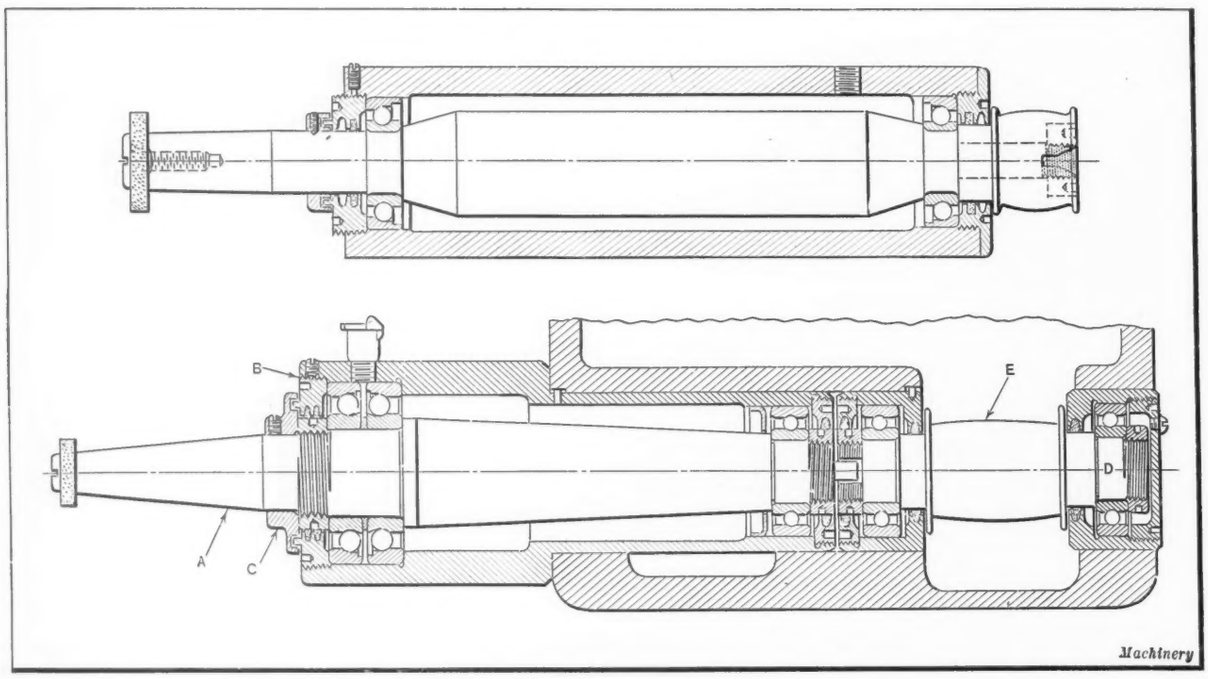


Fig. 4. High-speed Internal Grinding Spindles provided with Ball Bearings

center in or out from being transmitted to the bearings. As will be evident from the illustration, this installation is of a simple design and involves no difficult machining operations.

Geared Headstock Equipped with Ball Bearings

In the all-geared lathe head shown in Fig. 3, there are eleven separate ball bearings, although only two styles of ball bearings are used. The shaft *A* on which the driving pinion *B* is mounted is equipped with two self-aligning S K F ball bearings. The inner races of these bearings are a tight fit on the shaft, and are prevented from working loose by having the hub of pinion *B* clamped against the inner race. The self-aligning bearings on shaft *A* make the shaft self-aligning with respect to pinion *B* and gear *C*, so there is a minimum frictional loss at this point.

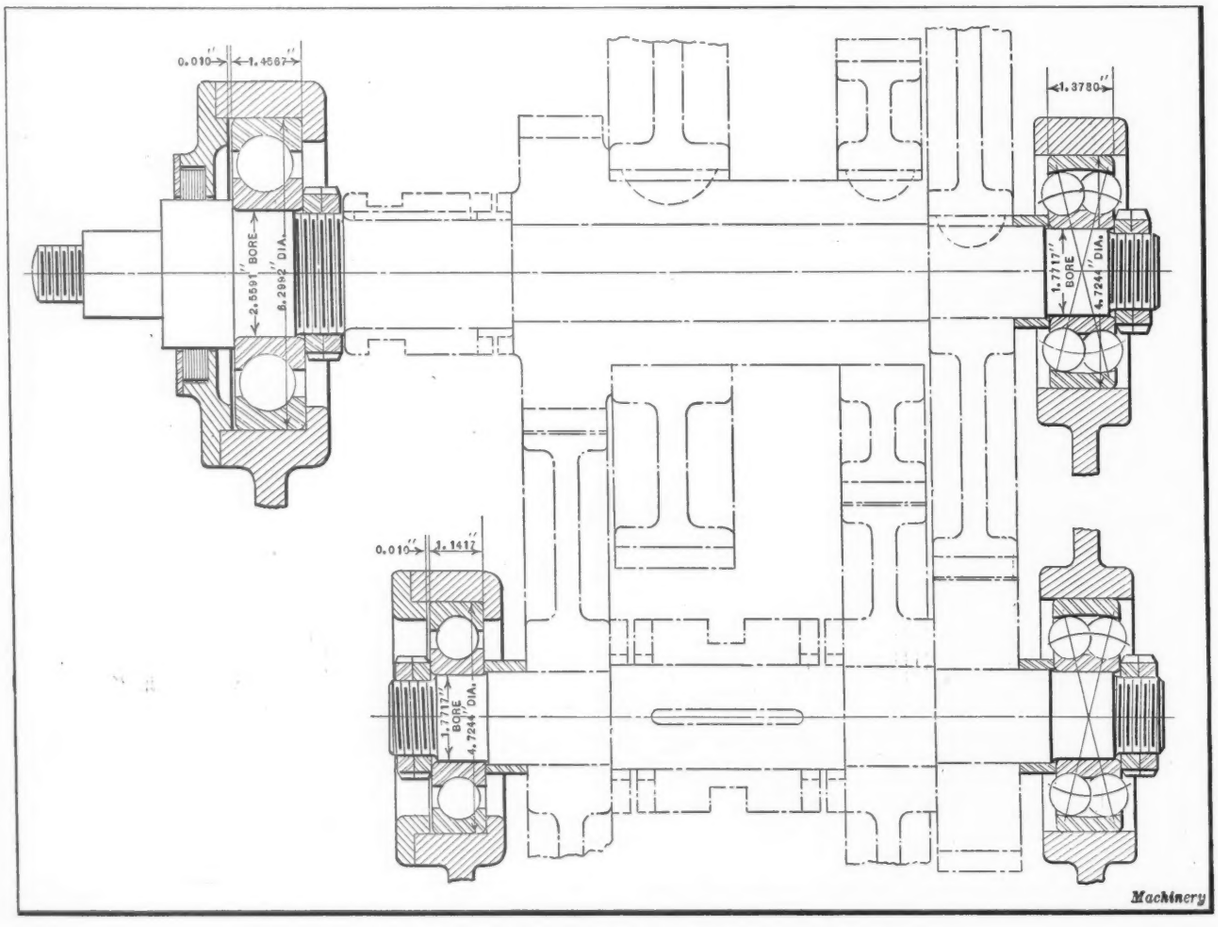


Fig. 5. Feed Gear Shaft used with Lathe Headstock shown in Fig. 3

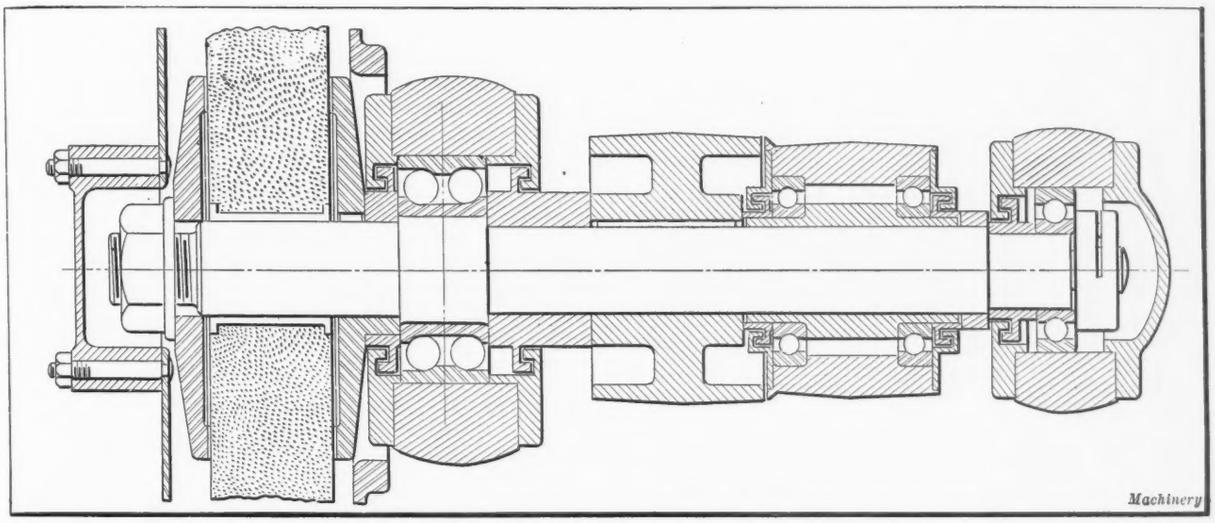


Fig. 6. Heavy-duty High-speed Ball-bearing Grinding Spindle

The shaft *D* which can be directly connected to shaft *A* by means of the clutch teeth at *E* is equipped with two deep-groove radial ball bearings and one self-aligning bearing which is located at the center of the shaft. Axial movement of the shaft is limited by the bearings at each end, which, being of the deep-groove type, are capable of taking considerable end thrust. The inner race of the self-aligning bearing, located midway of the length of the shaft, is a light drive fit on the shoulder turned on the shaft, and is prevented from working loose by the clamping nut *F*. The outer race of this bearing is not restricted in any way from axial movement. With this type of mounting, it is evident that any deflection of the shaft at its central point will not cramp or bind it in any way. This feature eliminates a common source of noisy gearing and undue power losses.

Shaft *G* on which the driven pulley *H* is mounted and which transmits power to the pinion-shaft *A* through shaft *D*, or indirectly through shafts *D* and *J*, is mounted in two deep-groove radial bearings. Bearing *K* is so mounted that it restricts the axial movement of the shaft within the desired limits, while the outer race of the bearing at *L* is permitted to have an axial movement. Pulley *H*, when running free with the clutch disengaged, rotates on the two deep-groove radial bearings. The method of mounting these bearings is clearly shown by the illustration. A large oil pocket between the two bearings on which the pulley runs eliminates the necessity for frequent oiling. The shaft *J* is mounted in two deep-groove radial bearings, the installation being similar to that employed for shaft *G*.

The bearing equipment for the feed gear shafts of the lathe head shown in Fig. 3 are illustrated in Fig. 5. S K F self-aligning ball bearings are used to support the right-hand ends of the shafts. The outer races of these bearings are permitted to have a sliding or axial movement, which allows the shafts to contract or expand with changes in temperature without causing deflection or cramping of the shaft. Deep-groove radial bearings, with only a slight allowance for axial movement of the outer races, support the left-hand ends of the two shafts. These bearings serve to maintain the proper location of the shafts.

Ball-bearing Grinding Machine Spindles

In the upper view of Fig. 4 is shown a ball-bearing grinder spindle designed for operation at speeds of from 15,000 to

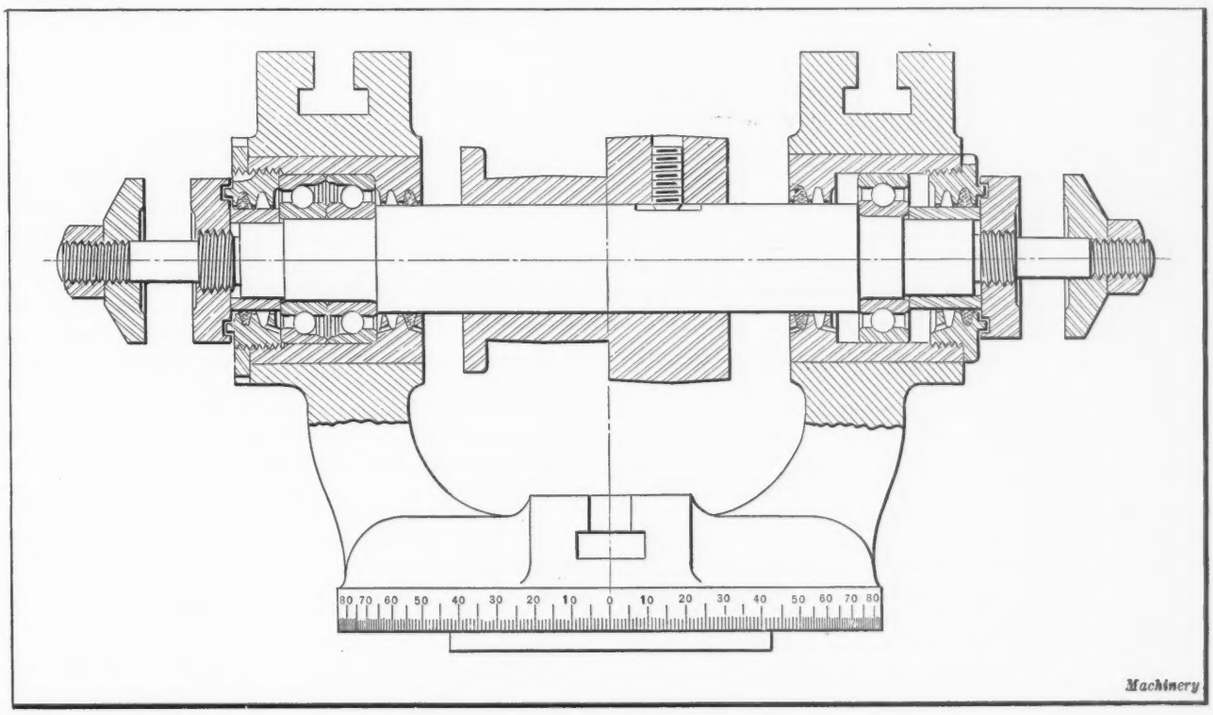


Fig. 7. Grinding Spindle mounted in Ball Bearings

25,000 revolutions per minute. This type of spindle is particularly well adapted for bore grinding. The bearings employed are of the Fafnir open (magneto) type. This type of bearing is constructed with a radial contact between each ball and the inner and outer races. The outer race is ground to the arc of a circle having a radius slightly greater than that of the ball. The shoulder on one side of the outer race is ground to form a cylindrical surface tangent to the race at its deepest point. With this type of bearing, it is a very simple matter to withdraw the inner ring and the ball retainer from the outer ring so that the bearing can be completely disassembled.

The duplicate parts of this bearing are manufactured to very close limits, so that they are interchangeable throughout. This feature, together with the simple method of assembling make bearings of this type particularly well suited for high-speed work where only light loads are involved. Following the usual method, the inner races are made a light drive fit on the shaft, while the outer races are a close slip fit in the housings. It will be noticed that the caps employed to retain the outer races of the bearings are grooved to receive packing rings which prevent oil from working out of the bearings and any abrasive particles from finding their way into them.

The high-speed grinding machine spindle shown in the lower view of Fig. 4 is driven by a short shaft in such a way that the belt pull on the shaft is not imposed upon the bearings of the grinding spindle. The head end of the grinding spindle *A* is mounted in two open (magneto) type bearings, and the opposite end in a single-row deep-groove bearing. In this installation, the inner rings are a light press fit on the spindle, and are prevented from becoming loose by threaded collars. The outer races of the two ball bearings at the head end of the spindle are held in place by the threaded ring *B*, which provides for the initial adjustment required to eliminate end play. The collar shown at *C* is secured to the spindle by means of a set-screw. Two deep-groove single-row ball bearings support the driving shaft *D* on which the pulley *E* is mounted. The left-hand end of shaft *D* is slotted to fit a projecting lug on shaft *C*, so that it will transmit motion to shaft *C* without exerting any side thrust on the bearings. The thrust or pull of the belt is thus entirely taken up by the two bearings that support the short shaft *D* at the right-hand end of spindle *A*.

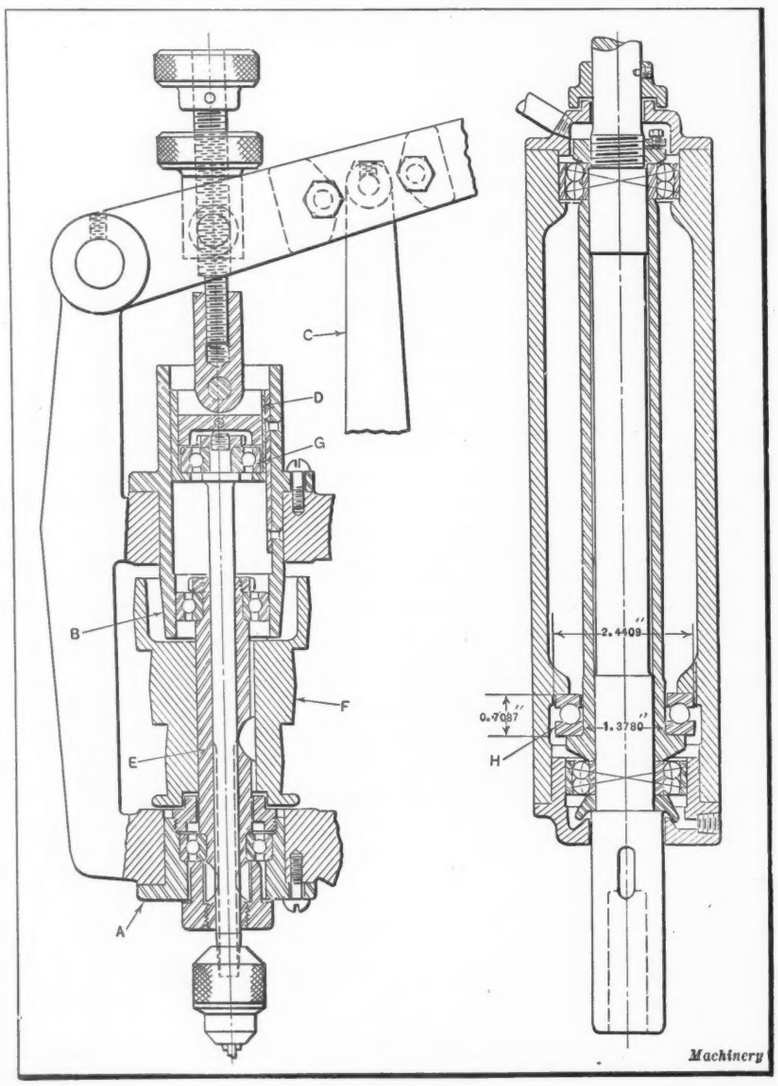


Fig. 8. Ball-bearing Drill Spindles

The heaviest load on the spindle of the high-speed heavy-duty grinder shown in Fig. 6 is carried by Fafnir double-row radial thrust ball bearings. A single-row deep-groove bearing supports the opposite end of the shaft in the usual manner. The tight and loose pulleys are mounted between the two main bearing spindles shown in the illustration. The two deep-groove single-row bearings, on which the loose pulley runs, are well protected from abrasive dust by interlocking flange plates as shown.

In Fig. 7 two of the open (magneto) type ball bearings are mounted face to face at the head end of the spindle, so that they take the thrust in both directions in order to maintain the correct axial position. The single-row ball bearing at the opposite end of the spindle has its inner race secured to the spindle, while the outer race moves freely in the housing.

The drilling machine spindle shown in the left-hand view of Fig. 8 is equipped with SKF ball bearings of the single-row deep-groove type. The main spindle on which the drill chuck is mounted is driven by a sleeve *E*, which is, in turn, keyed to the three-step cone pulley *F*. A ball bearing mounted in the bushing *A* supports the driving sleeve at its lower end. This bearing is so mounted that it keeps the spindle driving sleeve in the correct position. The upper end of this sleeve runs in a ball bearing in bushing *B*.

The downward feeding movement of the spindle is obtained by pulling down on the link *C*, which causes cylinder *D* to move downward. Within cylinder *D* is mounted a radial bearing *G* of the single-row type which, in addition to supporting the upper end of the drill spindle, also takes the thrust on the spindle. The view at the right-hand side of Fig. 8 shows another drilling machine spindle equipped with ball bearings. This spindle is intended for somewhat heavier duty than the one shown at the opposite side of the illustration. It is provided with SKF self-aligning bearings at the top and at the lower end. In this bearing the thrust imparted to the spindle by the drill is received by the ball thrust bearing *H*.

Sensitive Drill Equipped with Ball Bearing

The sensitive drill spindle shown in the view at the right-hand side of Fig. 9 is designed for operation at speeds of 12,000 revolutions per minute. Fafnir single-row radial bearings are used throughout, the method of mounting being

clearly shown in the illustration. The view in the lower left-hand corner shows one of the idler pulleys used to guide the belt that drives the spindle shown at the right. The sectional view in the upper left-hand corner shows the method of supporting the upper end of a drilling machine spindle of another make in Fafnir ball bearings. In referring to this view, it will be noted that the outer races of the bearings are mounted inside the pulleys.

* * *

MACHINERY INDUSTRY IN CZECHO-SLOVAKIA

The machinery manufacturers of Czecho-Slovakia have been very active in their efforts to build up a machinery industry within the country, and have developed a considerable export trade to the neighboring countries. So far, however, the imports exceed the exports. In 1921 the imports were valued at $14,000,000 and the exports were slightly more than $11,000,000. The imports were mainly from Germany and Austria, while the exports went to Italy, Jugo-Slavia, Poland, Austria, and Hungary. Czecho-Slovakia's leading exports in the machinery field were textile machinery, steam boilers, and distilling and refrigerating machinery. The imports from Germany and Austria consisted mainly of electrical machinery and automobiles. The principal item of imports from the United States consisted of metal-working machinery, while textile machinery was the largest single item in the imports from Great Britain. Machinery manufacturers in Czecho-Slovakia look forward with confidence to the building up of a large machinery trade with Soviet Russia.

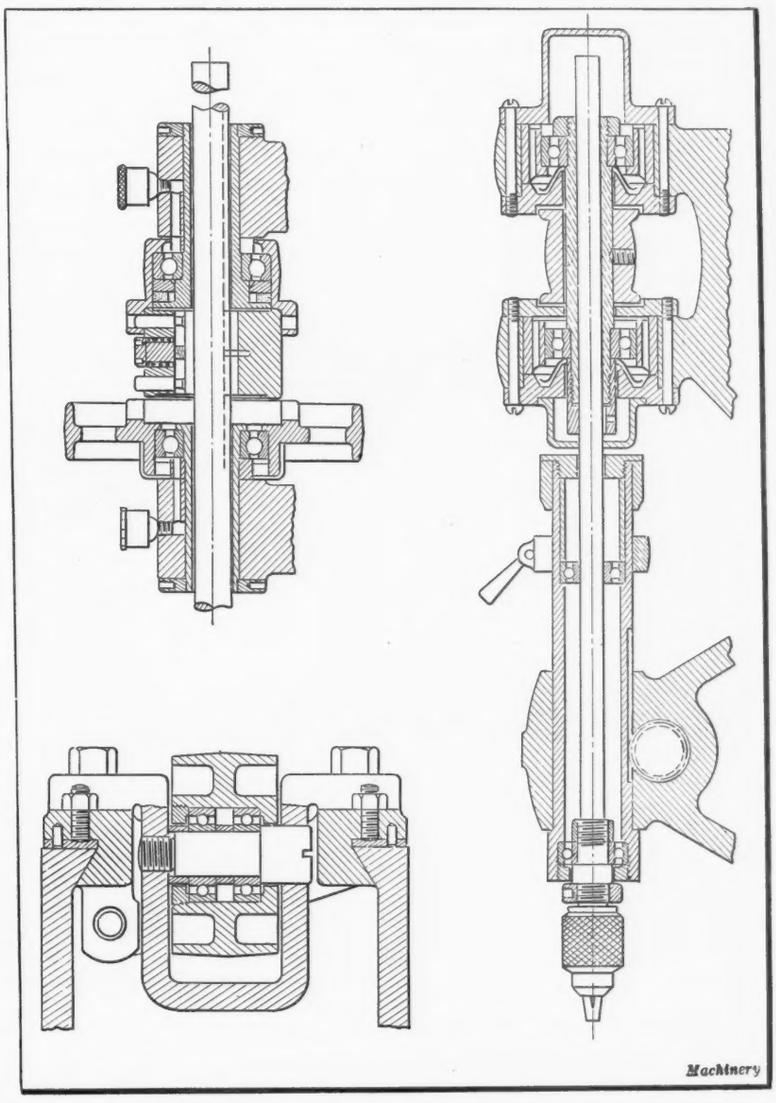


Fig. 9. Application of Ball Bearings to Drilling Machine Spindles and Idler Pulleys

* * *

If the railroads were corporations operated under the conditions of strictly private business, their success or failure would not be a matter of deep public concern. But they are not, in this sense, private enterprises—they are the life of the country, and on their progress and proper development, the prosperity of each and every American depends. Hence, to cripple them through legislation is not merely unethical—it is calamitous—and the penalty will be inflicted upon the people themselves.—*E. M. Herr, President, Westinghouse Electric & Mfg. Co.*

CASTING IN PERMANENT MOLDS

Quantity production of intricate iron castings by unskilled labor, using metal molds, was described in a paper on "Recent Developments in Permanent Mold Castings" by D. H. Meloche of the Holley Carburetor Co., read before a recent meeting of the Detroit Section of the Society of Automotive Engineers.

Previous to the last decade, the use of metal molds was largely confined to the non-ferrous field, the early attempts showing that gray iron poured into a metal mold produced an unmachinable casting, owing to the quick chilling of the surface. Further, the high temperature of the molten metal quickly raised the temperature of the iron mold until the two were welded together. This new development is the result of studying the production of intricate castings in large quantities, having a uniform homogeneous structure. The regulation of the cooling rate, which was obtained by the following steps, was found to be the important factor:

1. Controlling thickness of walls in the hollow metal mold, which are approximately ½ inch thick. The molds are of ordinary gray iron, cast to shape in a metal mold.

2. Providing a heat barrier between the molten iron and the metal mold, consisting of ordinary fireclay with a heat-resisting binder. This barrier is called a "stone facing" and is from 0.01 to 0.015625 inch thick.

3. Protecting of this stone facing after each casting by a coating of lampblack, applied by means of a smoky flame.

4. Preventing the expansion of the iron when freezing, by holding the parts of the mold together by powerful springs.

5. Controlling the temperature of the molds, a slight artificial cooling by a blower or a fan giving increased production.

6. Cleaning the molds after each casting. This is done by air blast, not only to blow out the sand and dirt, but to insure a fresh coating of lampblack.

All ranges of mixture of iron from ordinary malleable to ordinary cast iron have been successfully used. The shrinkage of the iron casting is about one-half that which would be expected when using a sand mold, probably because the iron takes the shape of the mold during the expansion stage rather than during the contracting stage.

PHOTOGRAPHIC METHOD OF DETERMINING MACHINE SPEEDS

By R. FRANKLIN MUNDORFF

In testing the efficiency of generators, motors, and other electrical machines, it is necessary to determine the amount of the friction losses, core losses, and various other factors. On the floor of the factory, the losses are measured by the motor drive method, but in the plant this method cannot be used because of the lack of suitable motors and other requirements. The photographic method of determining retardation of machine speeds described in this article eliminates the personal equation and the possibility of error that exists when successive speed readings are taken in the usual way.

The photographic method consists of photographing two dials at regular predetermined intervals, the smaller dial being located on the face of the larger one, as shown in the accompanying illustration. The hands of these dials are connected to the rotating object through reduction gears. The camera is operated at an exposure of about 0.01 second. The first dial is divided into ten parts and connected to the shaft through a gear ratio of 1 to 100. Hence ten revolutions of the shaft move the hand on the first dial one division. The second dial is also divided into ten parts, but each part is again divided into ten subdivisions. The hand of this dial is connected to the shaft through gearing having a ratio of one to ten. It follows then, that one revolution of the shaft moves the hand of the second dial one main division, while one-tenth of a revolution of the shaft moves it one of the subdivisions.

Set-up for determining Retardation of Machine Speeds

The reading of one exposure is subtracted from the reading of the one immediately following, the difference indicating the number of revolutions the rotating shaft has made during the time interval selected. If this number be divided by the number of seconds in the interval, and multiplied by 60, the result will be the average speed in revolutions per minute of the rotating element.

If several successive exposures are taken, the average speed for each interval can be accurately determined. The data thus obtained should be plotted. The camera shutter is operated by a small solenoid which is energized through a contact-making device that closes the circuit every six seconds. This device is attached to a synchronous motor. A period of six seconds is selected, so that the multiplying constant representing the difference between the dial readings is 60 divided by 6, or 10. Therefore, if the second dial is read to the nearest subdivision, the difference in the readings of successive exposures will give the average speed in revolutions per minute for the period.

In making a test, the procedure is as follows: Place a roll of film in the camera and see that the timing device is working, which will be indicated by the pilot lamp. Bring the machine up to the speed required and then light the large lamps that illuminate the dial. In about four seconds after the pilot lamp flashes, open the source of power to the machine under test and at the same time close the switch in the solenoid circuit. After each click of the solenoid, advance the film in the camera for the succeeding exposure. This advance can be easily made in three seconds. An automatic device could be attached to advance the film either by steps or continuously.

The determination of core loss by the retardation method consists chiefly in determining the rate of retardation and applying the data obtained in the common energy formulas for moving bodies. The machine to be tested is brought up to a speed which is higher than normal by means of the local power supply, then disconnected from that supply and allowed to drift down, the speed being read at intervals of five or ten seconds. The method described was originated and the equipment for applying it arranged by D. W. Proebstel, assistant engineer of the Portland Railway, Light and Power Co., Portland, Ore.

* * *

PREPARING TECHNICAL PAPERS

"The preparation of a technical article or paper," says the *A. S. M. E. News*, "is an art—perhaps an art that engineers have not had the time to cultivate, but one whose acquisition is of prime necessity if meetings of engineers are to be successful." The following points are given, not only as an aid to the young engineer who may be presenting his first paper before a society, but also as a reminder to some of the older engineers. They apply equally well to anybody who has to present any matter in speaking to others, whether it be before a society or association, a board of directors, or a shop conference. The fundamental rules are as follows: Be brief and concise; point out the important features clearly and simply; state results and conclusions briefly and definitely; speak distinctly, slowly and loud enough to be heard; when explaining lantern slides, speak to the audience and do not talk to the screen. The value of a good paper or article is greatly enhanced by being well presented, either in speaking or in writing. Any man who expects to present a subject before others owes it to his listeners to thoroughly prepare himself, and he should give what he intends to say several rehearsals. The time spent upon this by one man (the speaker) saves the time of hundreds of men who attend the meeting.

* * *

It is gradually becoming evident that the traffic problem of American cities is too big for police departments, chambers of commerce, and merchants' associations. The engineer is being recognized as the only man who, in his professional capacity, can be expected to solve the problem. The New York *Tribune* recently stated that to provide New York City with permanent and adequate avenues of traffic is a greater engineering undertaking than even the Panama Canal, or the Catskill aqueduct. Only a commission formed of experienced engineers and progressive business men can deal successfully with this problem. The same problem presents itself in every large city in the United States. As a matter of fact, the traffic problem is no more serious in New York than it is in Chicago, Philadelphia and a dozen other of our largest cities. The only way in which it can be approached with any hope of successful solution is by analyzing the problem in an engineering manner and solving it as any other transportation engineering problem.

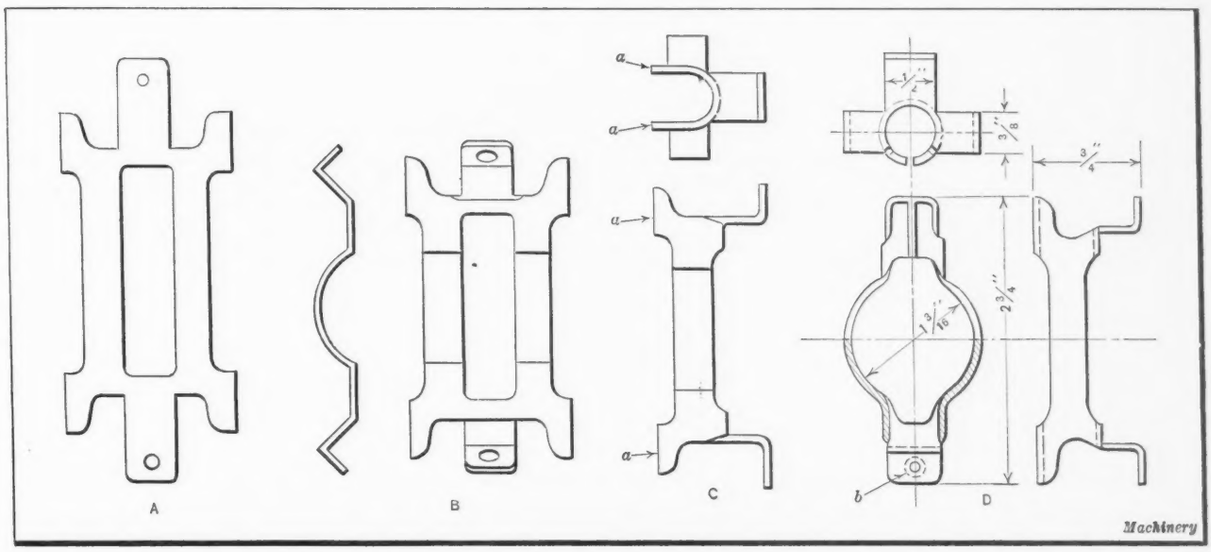


Fig. 1. (A) Pierced and Blanked Part; (B) Blank shown at A, after First Forming Operation; (C) Result of Second Forming Operation; (D) Part as it appears after Final Forming Operation

Dies for Producing a Complicated Sewing-machine Part

By C. E. STEVENS, Chief Engineer, White Sewing Machine Co., Cleveland, Ohio

AN interesting example of sheet-metal work, produced by the use of four dies, is shown at *D* in Fig. 1. This part is used in a sewing machine. It is made from soft cold-rolled steel strip stock, 4½ inches wide by 0.065 inch thick. While only a few rough dimensions are shown in the view at *D*, in order to give the reader a good idea of the size of the part, many of the actual working dimensions are required to be held within very close limits.

Piercing and Blanking Die

The first operation on this part—piercing and blanking—is performed by the progressive type of die shown in Fig. 2, which produces the blank shown at *A*, Fig. 1. The piercing and blanking die consists of a cast-iron shoe *A* on which is mounted the tool-steel die-block *B*. A plan view of the die is shown at the left-hand side of Fig. 3. The view at the right is a plan view of the end of the punch. The two piercing punches *C* produce the holes in each end of the blank, as shown at *A*, Fig. 1. These punches are in line with the punch *D*, Fig. 3, that produces the rectangular opening in the blank. The stock is pierced by punches *C* and *D* at the first stage, as will be evident by referring to the plan view of the die. The pierced part is blanked out in the second and last stage by the punch *E* so that it passes through the die opening at *F*. The stripper *G*, Fig. 2, is made of cold-rolled steel, 5/16 inch thick, and has openings that correspond with those in the die-block; these openings are made about 1/64 inch larger than the punches. The strips *H* and *J* are made from cold-rolled steel, 1/8 inch thick, and act as spacers for the stock. Strip *J* also acts as a back gage or guide for the stock when it is being fed through the die. The stripper, gage strips, and die-block are fastened to the die-shoe by four 15/16-inch fillister-head screws and four dowel-pins.

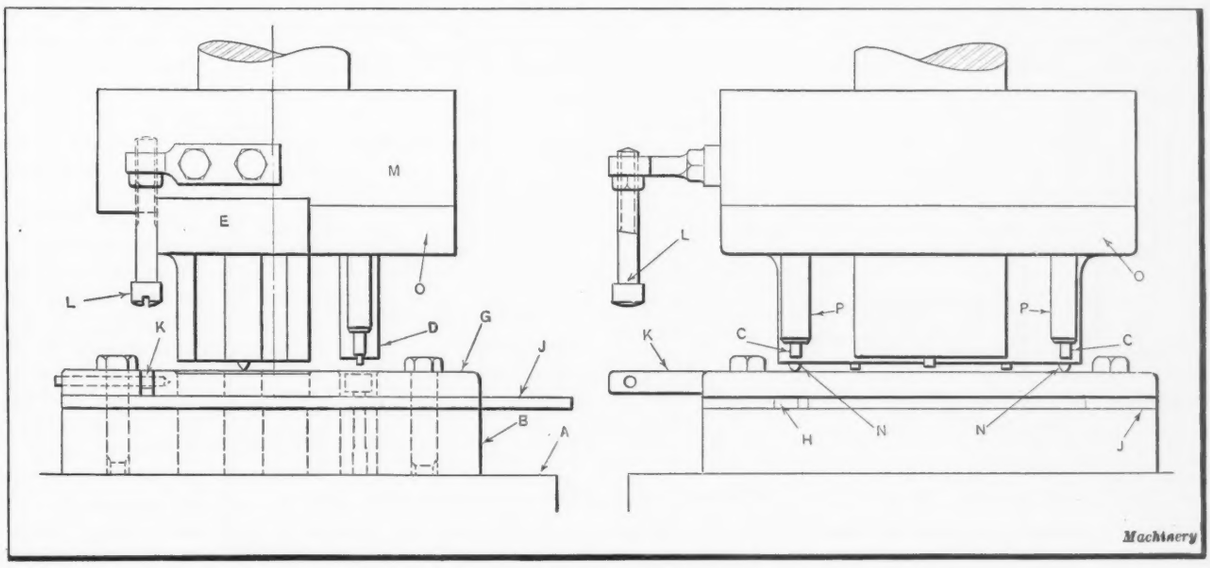


Fig. 2. Front and Side Views of Die used to blank and pierce the Part shown at A, Fig. 1

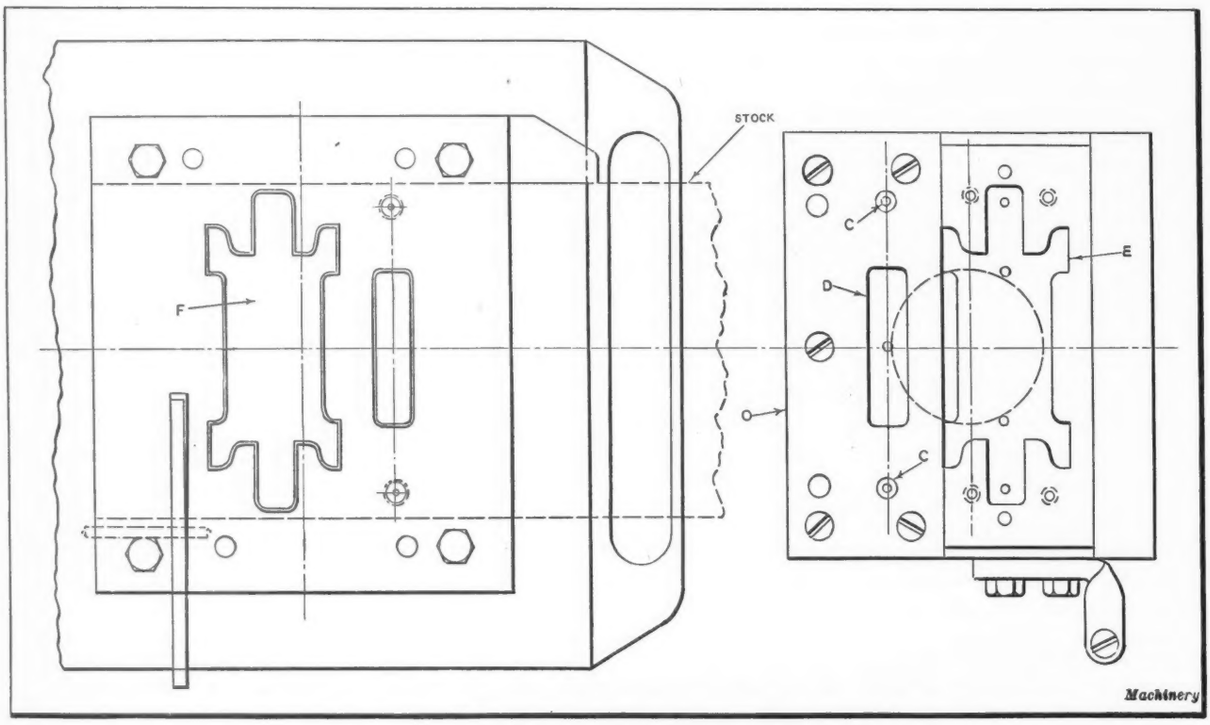


Fig. 3. Plan Views of Blanking Die and Punch shown in Fig. 2

The stripper is slotted to receive the finger *K* which is made of cold-rolled steel and casehardened. The finger is of the automatic type and is operated on every downward movement of the press ram by means of a trip-screw *L* attached to the punch-holder. This permits the press to be operated continuously while the operator feeds the stock through the die. The punch-holder *M* is made of cast iron, and milled out to receive the punch *E* which is made of tool steel. Four fillister-head screws and two dowel-pins are used to hold the punch in place. Two pilots *N*, located in the punch *E*, enter the small holes pierced at each end of the blank and serve to center the stock over the die opening *F*, Fig. 3.

The piercing punches *C*, Fig. 2, are held in the tool-steel sleeves *P*. By employing punches of this type, a replacement can be effected without changing the alignment of the punch and die members, as it is only necessary to drive the small center-punch out and insert a new one in the sleeve, which remains stationary in the punch pad. The pad *O* is made of machine steel, and carries the slotting punch *D* and the piercing punches *C*. Punch *D* is provided with a small spring-actuated kicker which keeps the slug from being withdrawn with the punch and left on top of the die where it may cause considerable trouble or damage to the die. The press is operated at a speed of 90 strokes per minute for the blanking and piercing operation. The blanks are tumbled, to remove any burrs which might cut the hands of the workmen in succeeding operations.

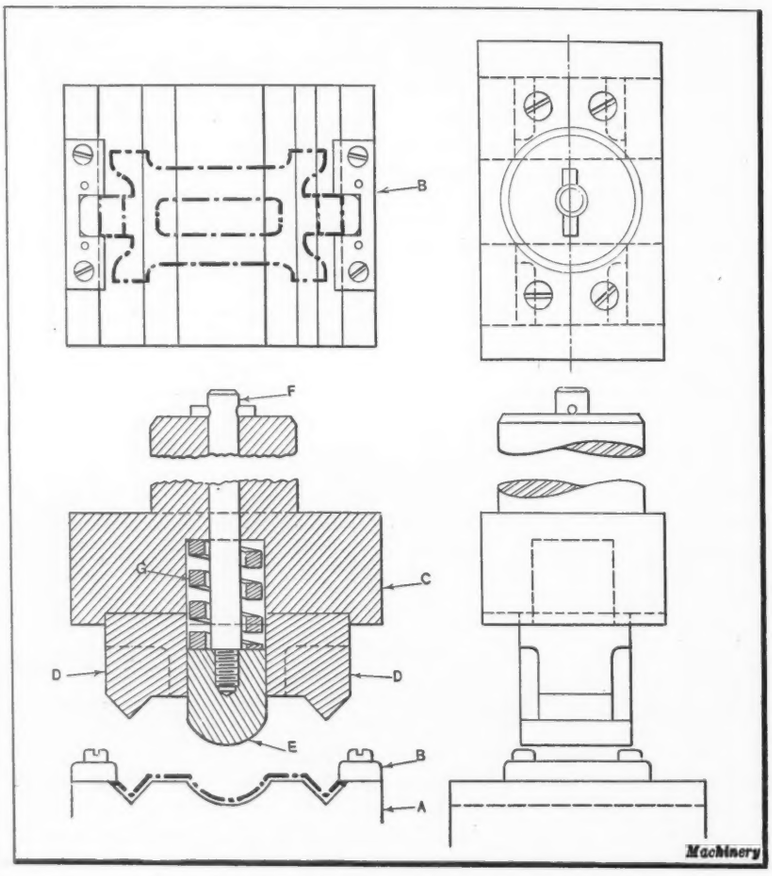


Fig. 4. Die used to form Part to Shape shown at B, Fig. 1

The second die used in the production of this part is shown in Fig. 4. This die bends or forms the part to the shape shown at *B*, Fig. 1. The pieces are formed to a radius at the center, while the ends are formed or bent to an angle of 45 and 90 degrees. The tool-steel die-block *A*, Fig. 4, is mounted on a cast-iron shoe. It is milled to the shape shown by the two views in the lower part of Fig. 4. On block *A* are mounted two gages *B* which hold the blank in the position shown by the dotted lines in the plan view. The cast-iron punch-holder *C* is milled out to receive the two end-forming blocks *D* and the spring plunger *E*, which is held in place by the pin *F*.

The blank is placed between the gages *B*, and as the ram of the press descends, plunger *E* is brought against the work so that it forms a semicircle or radius section in the blank, the spring *G* being strong enough to form the metal to the radius to which the punch and die are machined. This section draws the stock in, or in other words, draws the ends away from the gages or locating blocks *B*. As the ram continues to descend, the punch *E* recedes and at the end of the downward stroke, the forming blocks *D* bend the ends of the blank to the desired shape. After being formed, the part is blown from the die by a blast of air from a piece of metal hose connected with a valve that is opened automatically on the up-stroke of the press.

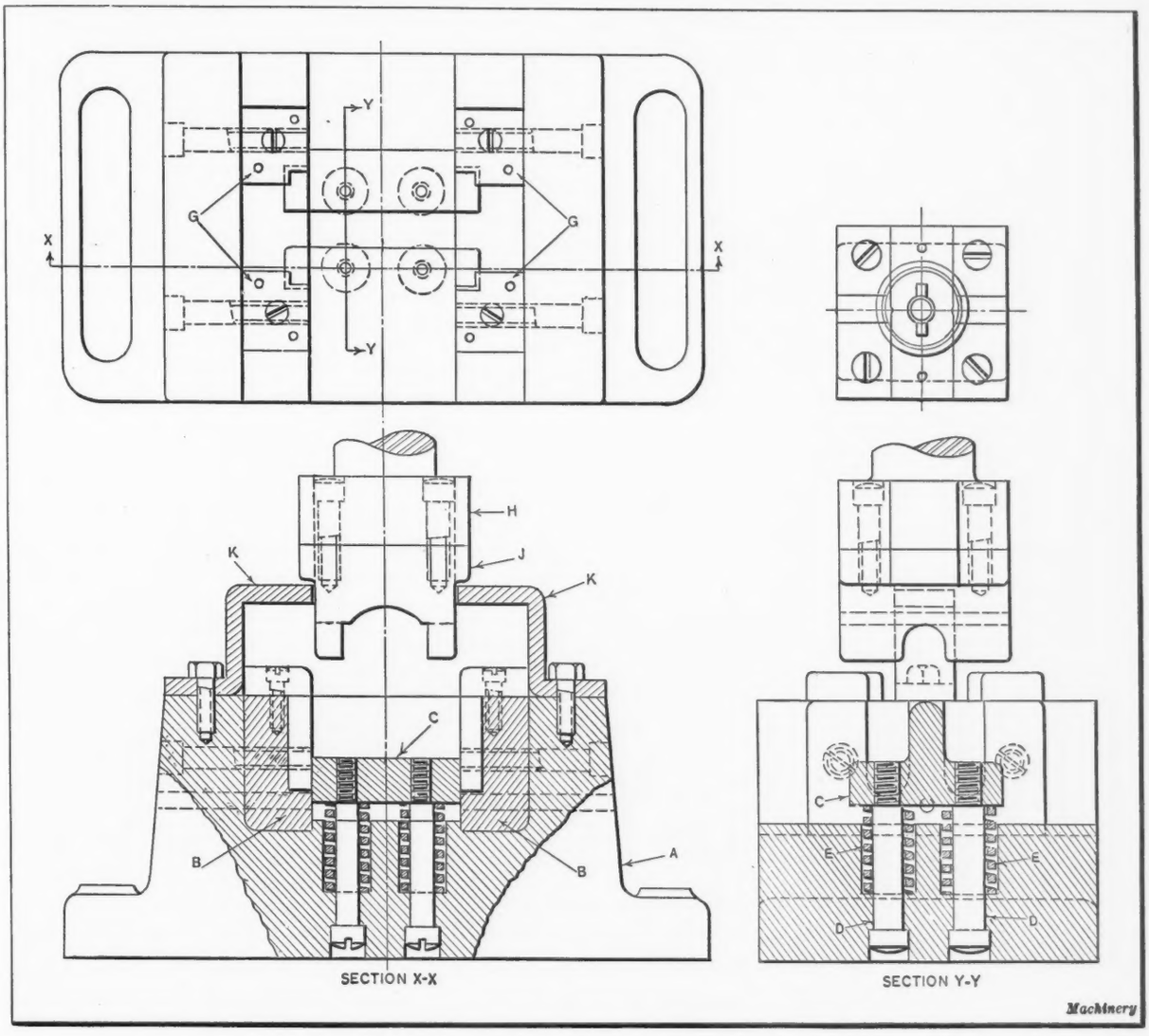


Fig. 5. Die employed for forming the Part to the Shape shown at C, Fig. 1

Die for Second Forming Operation

The die used for the second forming operation is shown in Fig. 5. This die forms the part to the shape shown at *C*, Fig. 1. The die-shoe *A* is of cast iron, and is milled out to receive the steel blocks *B*, and the plunger or pad *C*, which is held in place by the four screws *D*. The pad *C* is backed up by four coil springs *E* which fit loosely over screws *D*. These springs are also a loose fit in the counterbored holes in the die-shoe *A*. When the block *C* is raised, in its normal position, the top of the rounded end is flush with the top of the forming blocks *B*. The gages or locating blocks *G* are mounted on the forming blocks *B*, each being held in place by a fillister-head screw and two dowels. The locating blocks are machined so that the blank can be easily slipped into place and held without any perceptible play or looseness. The punch consists of a cast-iron holder *H* on which is mounted the tool-steel block *J*. Four fillister-head screws and two dowels are employed to hold block *J* in place.

In making this punch and die, the die members were hardened before a run of parts was made, while the punch was left soft and allowed to round or swage itself to fit the stock, after which it was hardened and polished. The four coil springs *E* have sufficient strength to allow the part to be formed to a U-shape before the descending punch causes pad *C* to be forced down to its seat in the die-shoe. The sides of the part are bent down at a right angle at the end of the downward stroke. The punch is so adjusted that a solid blow is given to the metal at the end of the stroke; this rounds it out and sets it to the desired shape. As the press ram ascends, the formed piece is stripped from the punch by the two fingers *K*.

Die for Final Forming Operation

The fourth and last operation is that of forming or bending the four ends *a* of the piece shown at *C*, Fig. 1, to form complete circles, as indicated by the views at *D*. The final bending operation is performed in the die shown in Fig. 6. This die consists of a die-shoe *A* to which is attached the forming block *B*. Each end of this block is turned to a radius 0.005 inch less than the outside diameter of the finished part, which allows for some recoil, such as usually occurs when parts of this kind are formed over an arbor. A slot of the same width as the ends of the part which are

bent at right angles is milled in each end of block *B*. When the work is placed in the die, the ends of the part are slipped into these slots, so that it is kept from turning while being formed.

The plug *C* is made a drive fit in block *B*. The large diameter of this plug is 1.185 inches, and is a slip fit for the part which is to be formed. There is a slot in the center of this plug which is ground to a good gage fit for the arbor, and locates it when the forming operation is performed. The two plungers *D*, which are backed up by springs *E*, are made of tool steel, and are a snug fit in the die-shoe *A*. The headless set-screws *F* serve to hold the springs *E* in place. The punch consists of the holder *G* to which is attached the block *J*. This block has a radius which corresponds to the one in block *C*. When the faces of blocks *J* and *C* are in contact, the circular grooves make a complete circle, which forms the work to the required size.

The punch-block *J* is bored out to receive a spring plunger *K*, held in place by a rod *L* which extends up through the shank of the holder and is secured by a short cross-pin *M*. The coil spring *N* is made heavy enough to exert the required amount of pressure for forming the ends of the piece over the mandrel *P*. The ends of the part are kept from opening by the plungers *D*, so that the small tapped holes *b* (see view *D*, Fig. 1) will be held to the correct center distance.

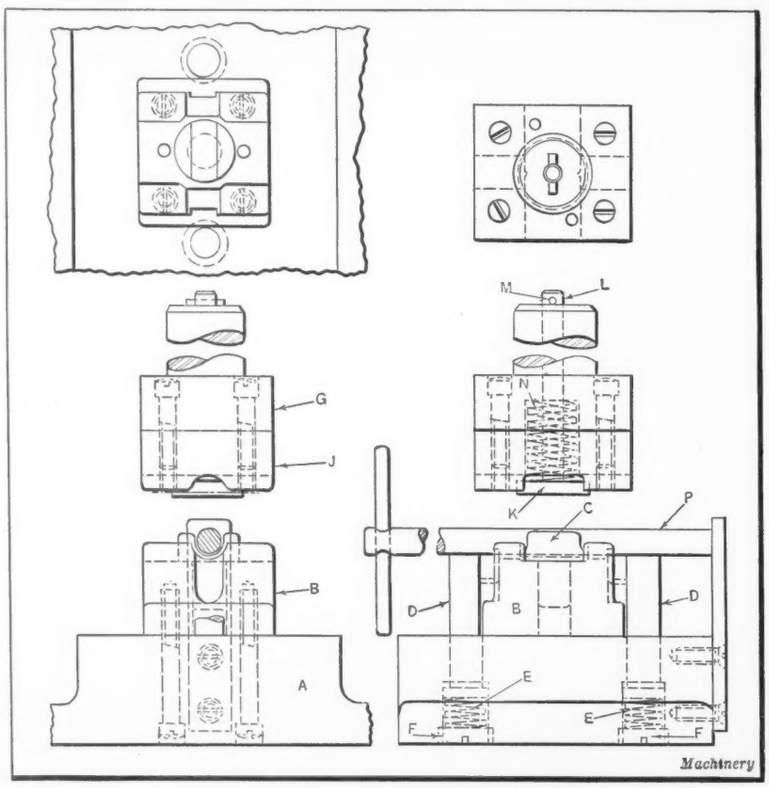


Fig. 6. Die used for Final Forming Operation on Part shown at D, Fig. 1

As the press ram descends, the spring plunger *K*, Fig. 6, forces the arbor down into place ahead of the forming punch so that the part is kept from slipping or turning. The press is adjusted to give the work a fairly heavy setting blow, which makes it fit the arbor *P* snugly. As the punch ascends, the spring plungers *E* force the arbor up about 1/16 inch, so that it can be readily lifted from the die by the operator, who then removes the part. The small holes are next tapped in the part, and it is completed by hardening in cyanide.

* * *

Engineers who are interested in specific facts relating to early inventions are referred to the historical notes given in a recently published catalogue of the collections at the Science Museum, South Kensington, England. These notes contain historical facts, as far as they are known, without any attempt at speculation, recording them in their correct relation, and thereby forming a valuable guide to the developments in various directions in the engineering field. The catalogue is in various sections; one, on railway locomotives and rolling stock, has just been published by H. M. Stationery Office, Kingsway, London, W.C., at 1 shilling. The introduction to this volume contains a condensed review of the development of the locomotive. The value of the catalogue is further enhanced by the many illustrations that it contains.

A CONVENIENT PATTERN RECORD

By P. H. WHITE

The keeping of accurate pattern records is of great importance in plants that have their own foundries, and of still greater importance in plants that depend upon outside foundries to furnish them with castings. The proper marking of all patterns is one of the first essentials of a reliable pattern record. Every plant has, or should have, a numbering system which has been carefully worked out to meet its own particular requirements. One of the simplest methods is to number each pattern the same as the drawing on which it is detailed. The drawing number is followed by a dash and the detail number. Thus, if there are details 3 and 4 on drawing No. 2846 which call for castings, the pattern numbers for these parts would be 2846-3 and 2846-4, respectively. The advantage of this system of numbering is that the pattern number is automatically provided by the drawing number so that it is entirely unnecessary to keep a separate record for the patterns.

Every pattern, and as far as possible, each part of the pattern, when it consists of more than one piece, as well as the corresponding core-boxes should be legibly marked with the pattern number. As soon as the pattern is completed, a record should be made which shows the pattern number, kind or type of pattern, number of core-boxes, date, name of the patternmaker who constructed the pattern, and cost. This record should preferably be entered on a suitable index card which may be either a plain or a printed form. The reverse side of the card (or the face, if so desired) should have space for recording all data relating to the transfer of the pattern from one place to another and the date on which the transfer was made. When the pattern is sent to the foundry, the date and name of the foundry are recorded on the card. When the pattern has been returned, the date and its location in the storage vault are also recorded. A pattern record of the kind described, if faithfully kept, will give a complete history of every pattern from the time it is made until it is discarded or superseded by a new design.

* * *

The most powerful steadying influence of an economic character in the entire world today is the enormous consuming power of the American people. In spite of the fact that in many fields foreign trade has been limited during the last few years, American industry, on the whole, produced in 1923 more than it had ever produced before. According to the statistics of the Federal Reserve Board, the production for the first ten months in 1923 was considerably more than 20 per cent greater than for the corresponding period in 1919, and almost 20 per cent greater than during the boom year of 1920.

Training Draftsmen and Patternmakers

Outline of Courses Given at the Worcester Boys Trade School

THOSE who read the article in April MACHINERY describing the methods followed in teaching the machinists' trade at the Worcester Boys Trade School, Worcester, Mass., may have received the impression that so much stress is laid on making the course successful that the other nine trades taught at the school are slighted. Such an impression would be erroneous, because the thoroughness with which the machine shop work is planned is also characteristic of the other courses. The aim, so far as each individual course is concerned, is to train the ambitious young man to meet the requirements of modern industry. How this is done in the draftsmen's and patternmakers' courses is outlined in this article.

Course in Mechanical Drawing

The course in mechanical drawing, like the machinists' course, consists of four years of three terms each, during which each alternate week is spent in the drawing-room, while the intermediate week is devoted to academic studies. The first work given boys in the drawing-room consists of lettering exercises, laying out geometrical problems, making orthographic drawings from models and sketches, making drawings from free-hand sketches on which one view is missing, and similar exercises. The manner in which the boys do this work soon shows whether or not they possess the temperament essential to a good draftsman. The prime requisites are carefulness, neatness, patience, and a mechanical turn of mind.

Boys who are obviously not fitted for this trade are persuaded to try one of the others, but if they persist in wanting to become draftsmen, they are permitted to remain in the course until it becomes apparent to them that they are unsuited for this line of work. Although boys are admitted to this school from fourteen years of age and upward, by far the majority of the boys in this course have had one or more years of high school education before enrolling. Of the boys who complete the first term, about 40 per cent graduate at the end of four years. There are at present sixty boys enrolled in the day classes.

In addition to the first-year work mentioned, the boy is taught to make blueprints, free-hand sketches of models and castings, simple assembly drawings, intersections and developments, etc. During the second year he makes detail and assembly drawings of lathes, is given spur gear problems, lays out simple cams and similar work. The entire shop time, or seven weeks of the middle term, is spent in the machine shop in order that the boy may become thoroughly acquainted with the machines on which is done the

Fig. 1. A Class in Mechanical Drawing at the Worcester Boys Trade School

work that mechanical drawings call for. During this term he is taught to operate drilling machines, to turn and thread work in the lathe, to file, and to run the shaper. During the third year he spends a similar amount of time in the machine shop, when he is given instruction relative to boring and threading operations on the lathe, milling machine and planer operations, lay-out work and templet making, cylinder grinding and bench work.

The drawing work of the third year consists of making detail and assembly drawings of a drilling machine, drawings of bevel and worm gearing, lay-outs of complicated cams, etc. A knowledge of pattern shop methods is just as essential to the draftsman as a knowledge of machine shop operations, and so in the fourth year the boy spends one term in the pattern shop learning how to construct pattern and core-boxes, and receiving general information that will be of future value.

The fourth year drawing course consists of making drawings of jigs and fixtures, installations, mechanisms of original design, and spiral gears, and in addition to this, the boys are taught the procedure followed in checking drawings. Fig. 2 shows an assembly drawing of a shaper completed by one of the boys from detail drawings made from free-hand sketches of the various parts. All drawings of the work that is produced in both the machine shop and pattern shop are made by the boys who are taking the drafting course.

In the one hour of shop instruction given by the drafting department supervisor to each group of students during the week they spend in the academic department, the boys are taught such higher mathematics as will later be necessary in solving the problems of their trade, and strength of materials; they are also given slide-rule instruction, gear problems, etc. The academic work is practically the same as that given to the machine shop students, which was outlined in the previous article. However, drawing is not taught to the students taking the draftsmen's course, in connection with the academic work, this time being devoted to shop instruction.

Learning the Patternmaking Trade

No better idea can be given of the class of work turned out by the boys following the course in patternmaking than by referring to Fig. 4. Here are illustrated patterns for large spur gears, a large globe valve, countershaft cone pulleys, etc., and core-boxes for a number of parts. Considerable pride is taken by this department in two electroliers which won a prize at the Pan American Exposition for the beauty of their design. The pattern for these, as well as for two bronze light columns about 8 feet high, on each side of the main entrance to the school building, were made by the boys.

During the first year, the boys are taught how to make simple flat-back patterns and core-boxes; do simple lathe work; operate such simple machines as grinders, trimmers, sanders; mix shellac, and similar work. In the second year, patterns are made for gears, pipe fittings, etc., and patterns with stop-off pieces are also constructed. During the third term the students make sketches of patterns, check work, act in the capacity of foremen, and make more intricate patterns, such as five-arm pulleys and guards. One term out of this year is spent in the mechanical drafting department. In the fourth and final year of the course, complex core work of all varieties is made, as well as difficult lathe work. Typical examples are the patterns and core-boxes for a lathe gear-box, and metal patterns. The shop is well equipped with practically all types of woodworking machinery. Some work is done for outside concerns, and, of course, all patterns required for the machine shop of the school are made. Practically all wood finish in the corridors and rooms of the school, as well as the desks, chairs, and lockers, were made by the students in the woodworking department.

In the shop instruction classes conducted by the supervisor of the woodworking department, the opportunities of the trade are first pointed out, and then the various tools and their uses are explained, as well as the different kinds of woods, board and linear measure, methods of drying and

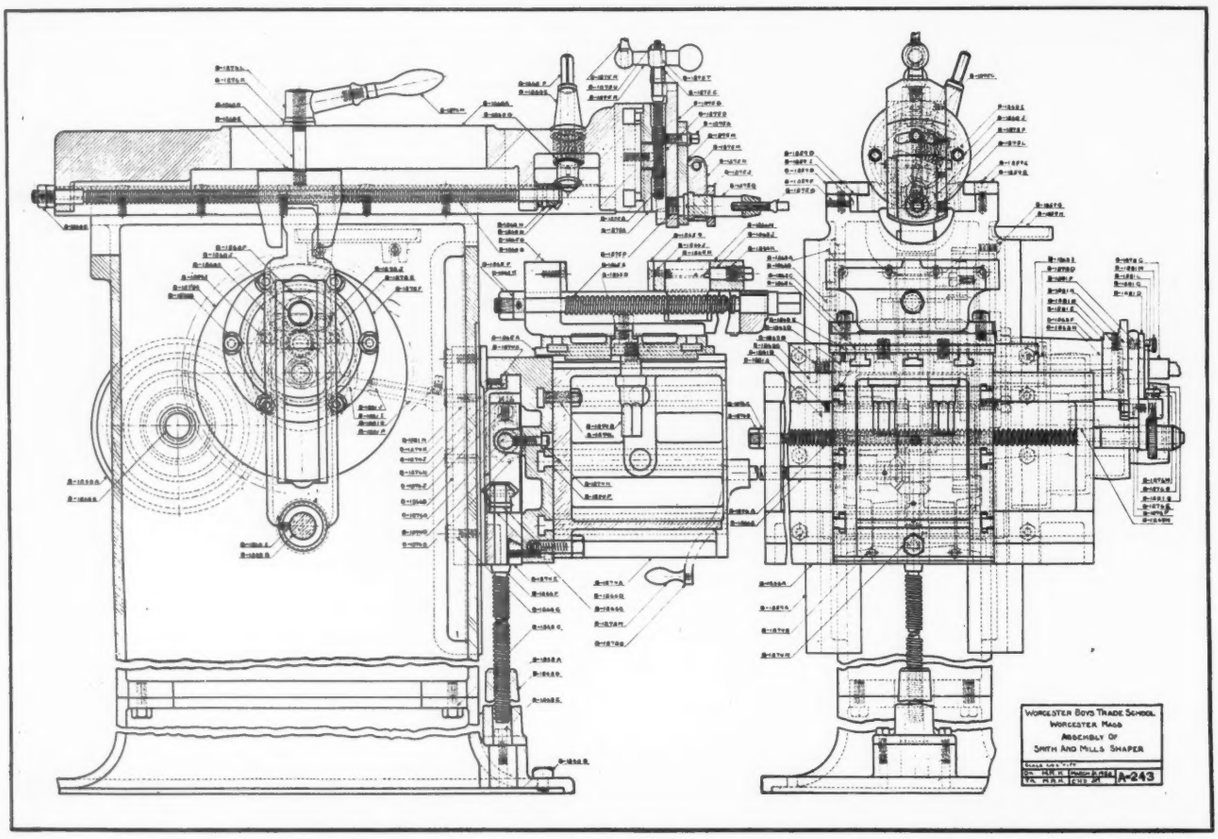


Fig. 2. Assembly Drawing of a Shaper made from Sketches of an Actual Machine in the Shop

Fig. 3. Learning the Trade of Patternmaking in a School where there is a Real Shop Atmosphere

shrinking wood, etc. In the second year, the speeds of tools, defects in woods, pattern and core-box construction, molding, power transmission, etc., are taken up. Health and sanitation, setting up machines, testing machines for speeds, and estimating stock for different jobs are some of the subjects considered during the third year, and in the final year there are discussions on such subjects as problems of the trade, wage conditions, duties of a foreman, shop ventilation, etc. The academic work is similar to that of the draftsmen's and machinists' courses. It has been found that the patternmaking students take readily to mechanical drawing, probably because of the large amount of lay-out work involved in their trade. There are about eighty boys taking the patternmaking course at present, twenty-five of these being four-year students.

Why the School is Successful

One of the prime reasons for the success of this trade school is that the work is in no way controlled by men who are purely "educators" in the commonly accepted meaning of the word. The director is a mechanical engineer with years of experience in practical work, and all the instructors have worked at the trade they teach. The director is not responsible for the affairs of the school to the Board of Education in charge of the grammar and high schools of Worcester, but to a special board of trustees which is appointed by the Mayor and approved by the City Council. Altogether there are between 550 and 600 day students enrolled in the different courses.

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AVAILABLE WATER POWER

Statistics collected by the Geological Survey Department of the Interior show that there are at present about 3200 water power plants in the United States of 100 horsepower or more, having a total installed power capacity of over 9,000,000 horsepower, an increase of nearly 15 per cent over the total in 1921. Of this total, 81 per cent is used in public utility plants and 19 per cent in manufacturing plants. New York, with over 1,500,000 horsepower, is still the leading state in developed water power, with California a very close second; the state of Washington is third; Maine, fourth; and North Carolina, fifth. A survey has also been made of the potential water power in the United States. In this respect, the state of Washington leads, closely followed by Oregon, California, and New York. A large proportion of the potential power in the state of New York is available continually, due to the flow of the Niagara and St. Lawrence rivers. Assuming that all the potential water power could be eventually developed, the installed capacity would reach 72,000,000 horsepower, or approximately eight times the present installed capacity.

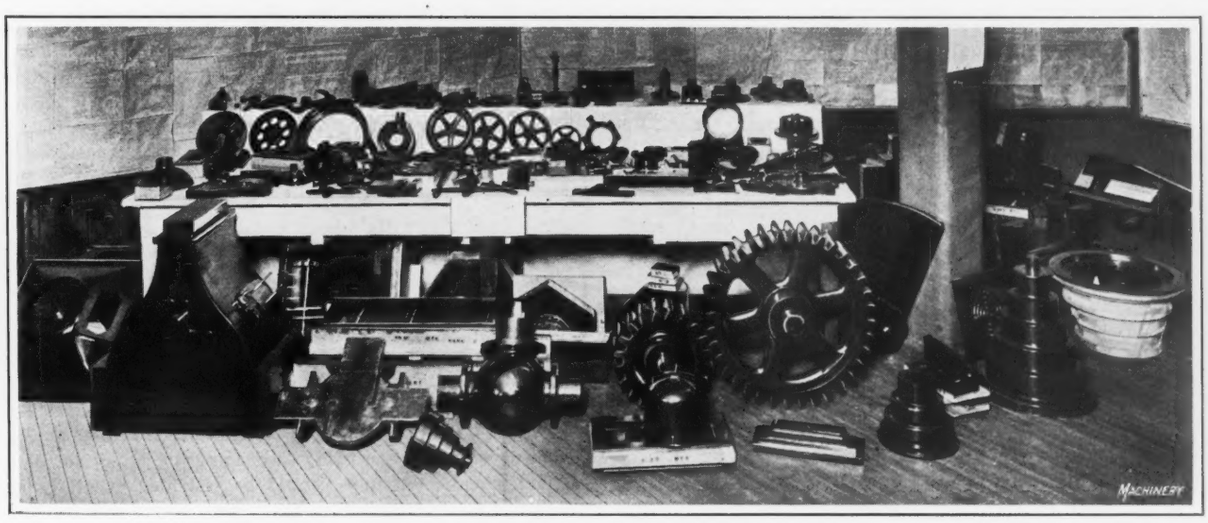


Fig. 4. Patterns and Core-boxes Representative of the Work turned out by the Boys

Designing Steel Castings

Second of Two Articles Dealing with Problems Encountered in the Production of Steel Castings

By E. R. YOUNG, The Detroit Steel Casting Co., Detroit, Mich.

THE methods employed by the foundry in which steel castings are to be made should be carefully considered before constructing the patterns. Much more satisfactory castings will be obtained and delays avoided if care is taken to construct the patterns so as to meet the particular requirements or conditions in the foundry where they are to be molded. There are some types of castings, however, which must be molded in certain ways in order to obtain the best results. In such cases the foundry should modify its regular practice to meet the requirements of the designer, if possible.

When relatively small holes are required in thick sections of heavy castings, it is preferable to avoid the use of cores and to drill or otherwise remove the metal. An excellent example of a casting of this type is the ram of a steam hammer. There are three objections to coring out the bore of the ram. In the first place, the sand of the core will "burn in," because the heavy section of metal surrounding the sand core subjects it to great heat and causes fusing of the sand and metal. This will occur in spite of great care on the part of the foundryman, and it will cause the boring tools to wear out quickly. Also the time consumed in machining is usually much greater than when the hole is drilled or bored from the solid metal. Another reason for not using a core in such cases is that it is likely to be forced out of position by the pressure of the molten metal. The core-print also interferes with the placing of a large sink head on the end of the ram, and makes necessary the use of two smaller heads, one on each side of the core. With the latter method it is more difficult to secure solidity in the body of the casting.

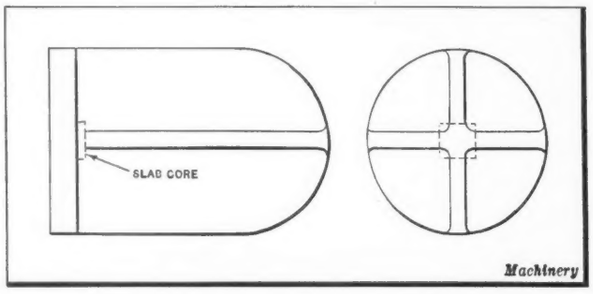


Fig. 1. Method of reducing Mass of Metal at Intersection of Several Parts

Die-blocks are another example of castings that require special molding methods. Good practice demands that these be cast on end, with the head on the end and not on the side. Time may be saved in machining by making the castings with projections and depressions so that the surfaces that require machining will be comparatively small. Now, if the parts of the pattern carrying the projections and depressions are not made as loose pieces so that the pattern can be drawn from the sand endwise, it may be necessary to cast it with the head on the side, which will result in an inferior casting. The difference of opinion among manufacturers as to the merits of cast-steel rams and die-blocks is, in many cases, due to the unfavorable experience of some users who received castings made under adverse foundry conditions which prevented the obtaining of a first-class product.

On the majority of castings there are some parts that have working or wearing surfaces or surfaces that require a very smooth, true finish. Such parts should be made in the lower part of the mold, or drag, as any foreign material which may be entrapped, or sand which may be washed loose by the metal, will rise to the top of the mold and appear on the upper or cope side of the casting. There is also less chance of sponginess in the lower part of the casting where the pressure of the metal in the sink heads, or risers, is most effective in securing solidity.

It is a simple matter for the foundry to take proper care of these important surfaces, provided it is informed regarding their location on the casting and provided also that the pattern is so made that it can be molded in the drag. If, for example, the rapping plates to be used in drawing the pattern from the mold are located on one of these surfaces, the logical thing is for the foundry to make the mold with this side of the pattern up, assuming that this is the customer's intention in so making the pattern.

Engineering or Structural Design

Castings range in design from very simple members to very complex structures and the proper designing of them is, accordingly, a simple or a difficult matter. With the usual design of simple castings, the foundryman has very little concern as regards the unit stresses. The sections are generally ample, considering the load applied, as a generous factor of safety is always employed. The strains imposed on a casting during solidification and cooling in the mold are, in a measure, a test of its strength while in a much weaker condition than that in which it will be used.

The importance of some of the simpler rules of design, such as avoiding extreme concentration of stresses due to sudden changes of section, sharp corners, etc., is often brought to the designer's notice through failures caused by stresses set up while the casting is cooling. Such failures, which result in a scrap or a repaired casting, might not be duplicated in service under different loading conditions. For instance, a casting which cracked under tension in cooling might be under compression when in use. Nevertheless, the properly designed casting will stand up under cooling stresses as well as under working stresses, and with intelligent handling in the foundry, it should never come from the mold in a state of internal stress, which is but little short of failure.

To repeat what has been mentioned before, castings should be so designed as to avoid, as far as possible, sudden changes of section, such as the joining of light and heavy sections. The junction of two parts will always form a heavier section, but when one of these is three or four times as thick as the other, it is desirable to increase the section of the lighter part gradually where it joins the heavier one. This often amounts to a generous fillet. Sometimes unusually heavy bosses are responsible for this condition of a sudden change from a light to a heavy section.

One method of securing a more uniform section at the junction of several parts is to use a lightening core which cuts through the parts close to or at the intersection, thus reducing the mass of metal at this point. Fig. 1 shows such a core used where four webs or parts join a fifth part. This use of a core has been made the basis of a patent for a cast vehicle wheel. Castings should be provided at all corners with good fillets, which should be much larger in radius than would be used to relieve a sharp corner on a machined part.

The vital parts of a casting, which require maximum solidity, should not be surrounded with parts so light in section that the early "freezing" of the light parts will prevent adequate feeding of the important parts during solidification. This matter of properly feeding the different parts of a casting, with molten metal from the heads during solidification is one which can not be left entirely to the foundryman, although the latter, in most cases, can provide for the adequate feeding of molten metal to all parts of the mold by the proper location of heads and gates. Nevertheless, the designer should see to it that the sections are such as to permit adequate feeding.

The warping of castings is of considerable concern to the designer as well as to the foundryman. In a box-like or frame-like casting with thin walls, warping is practically unavoidable, and it becomes more pronounced the greater the length of the casting. When the faces on such a casting are machined to a true surface preparatory to assembling, the walls are very likely to be too thin at certain points where strength is required, as indicated in the view at the left-hand side of Fig. 2. Some designers avoid this trouble by using bosses to provide bearing surfaces for assembling other parts, as shown in the view at the right-hand side of Fig. 2. These bosses can all be machined and the parts accurately assembled, regardless of any irregularity in the outline of the wall, which will retain its full thickness at all points.

Castings of Intricate Design

As castings become more intricate and complex in design, the calculation of the stresses in the different parts becomes more difficult and finally impossible in the light of our present knowledge of compound stresses. Castings of this type are usually designed to have sufficient strength as regards the size of sections and the factor of safety.

Where irregular shapes are required, castings are usually employed, and therefore parts in which there is a concentration of stresses due to changes in section and in form are of common occurrence. The fact that there are parts where the stress is higher than the average unit stress for the section is quite generally recognized, but the extent to which the stresses at such points of concentration exceed the average stresses is, perhaps, not realized. The effect of an abrupt contraction in the cross-section of a piece under

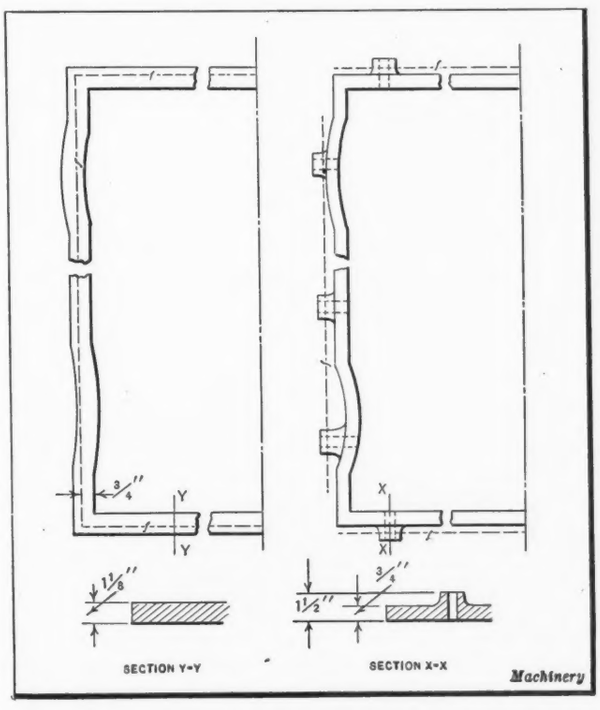


Fig. 2. Diagrams showing Casting with Warped Walls, and Method of using Bosses to obtain True Assembling Surfaces

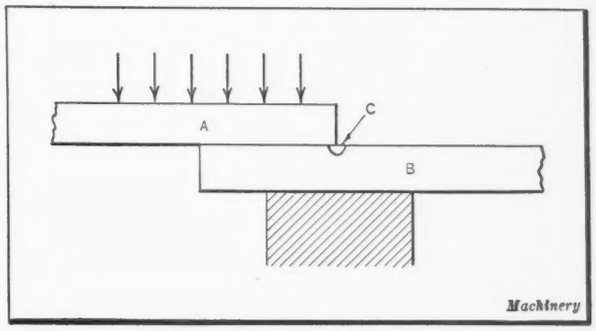


Fig. 3. Diagram used in describing Effect of Static and Impact or Reversed Bending Load on Steel Castings

tension or bending, in increasing the maximum stress, is really surprising. For example, in a piece under tension which has a round hole through the section, the calculated maximum stress at the periphery of the hole where the concentration of stress occurs is over three times the average stress in the section. Another example of such stresses is the maximum unit tensile stress occurring in a chain link. This, according to Johnson's "Materials of Construction," is about twice the average unit stress for open link chain, and 1.6 times the average stress for stud link chain.

It is easy to visualize castings or parts of castings, which, when under load, correspond to a tension member having holes or grooves in its cross-section, and also castings or parts of castings which, under load, correspond to a chain link under tension. Therefore, it can be stated that castings are frequently of a design that involves conditions of highly concentrated stresses. In some cases failure may be attributed to a lack of strength in the material, when the full strength has actually been developed under the peculiar conditions of loading. When we consider also that it may be difficult for the foundry to secure maximum solidity of metal at certain points, due to restrictions imposed by the location of other parts, we can readily see the need for thorough preliminary analysis of conditions by the designer in working out his sections and shapes.

Fatigue Strength of Castings

Steel castings are often used for parts subjected to repeated and reversed stresses, and which therefore must be capable of resisting what is known as fatigue failure. Our knowledge of fatigue strength and fatigue failure is being steadily augmented by the investigations being carried on, and it is desirable to apply as much of this information as possible in designing castings that may be subjected to fatigue stresses. The investigations of fatigue have not thus far covered the behavior of cast material, so that we can only draw conclusions in a general way from the results obtained on rolled material. We know that a fatigue break originates in a failure in a highly localized area—perhaps in an individual crystal, and that the fracture progresses through the section as the stresses are repeated.

It has been suggested that the lack of ductility of cast material greatly lessens its ability to withstand local deformation and equalize the stresses set up by local overloading and an initial crystal failure, and that this inability to suffer deformation results in a much lower fatigue strength or endurance limit. This would be true of cast iron, but it cannot be said that cast steel is without ductility. However, cast steel does have less ductility than the rolled material, and is also subject to non-uniformities both of structure and density, and to foreign inclusions which would lessen its fatigue strength. Points of local overloading which cause an initial fracture of crystals and a starting point for a fatigue break are of frequent occurrence and cannot be entirely eliminated. Such a condition is illustrated diagrammatically in Fig. 3.

The metal at *C* along the edge of the plate *A* which carries a load, will be under compression and will be over-

loaded, that is, stressed beyond the elastic limit at the immediate points of contact, which results in some local crushing of the crystals and permanent deformation of the metal at these points. This localized failure is of no importance so long as *B* is under a static load. But if *B* is subject to an impact load it becomes more important, and if a reversed bending load is applied to *B*, the overstressed condition at *C* would offer the starting point for a fatigue failure.

Applying this information to the subject of design, we see that in castings that are to operate under conditions of repeated or reversed stresses, the designer must take care to avoid any conditions that will result in local overloading through concentration of stresses, even though it be but a momentary overload. To accomplish this, ample size of sections under load, gradual change of section and outline, and uniform distribution of load are to be sought. In addition, the general design as to shape and relation of parts should be such as to aid the foundry in obtaining a casting that is uniformly sound and strong in all its parts.

* * *

MAKING PATTERNS FOR FLANGED PULLEYS

By M. E. DUGGAN

Some patternmakers and not a few designing engineers seem to be of the opinion that there is a standard method that should be strictly followed in making the patterns and molds for double-flanged pulleys. The writer believes, however, that there is no best or standard method and that the one to be used depends on the conditions to be met. A recent inspection of a store-room containing patterns that belonged to different manufacturers showed that quite a variety of methods were employed by different firms in making patterns for double-flanged pulleys like the one shown in Fig. 1.

Quite a few patternmakers use the method of constructing patterns for flanged pulleys shown at *A* in Fig. 2. In this type of pattern, a core is required between the flanges. The pattern is split through the middle, one half being molded in the drag and the other in the cope. Some molders do not approve of this method, for the reason that sand bars are required to support the sand in the cope half of the mold if the wheel happens to be of considerable width. Patternmakers who have constructed molds in this way are often surprised to find, on the return of their patterns from the foundry, that the two halves have been fastened together and the ring within the rim of the pulley has been molded in a dry sand core. The dry sand core is suspended and secured in place by means of wires that pass up through the mold, their ends being wrapped around wooden bars that rest on the top of the cope flask.

The pattern shown at *B* is made with the side of the rim square or slightly tapering. This is a one-piece pattern with the cope part of the hub *G* loosely attached to the main

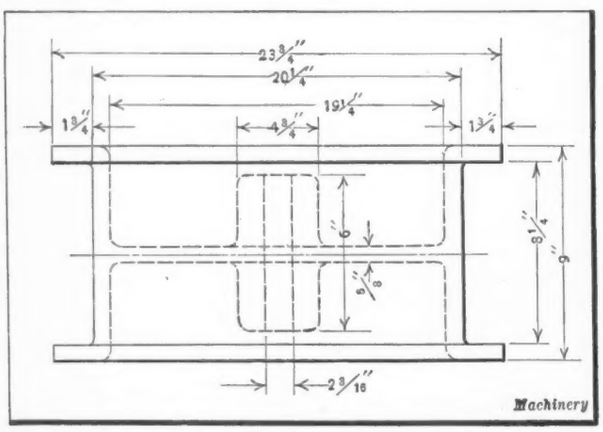


Fig. 1. Flanged Pulley of Typical Design

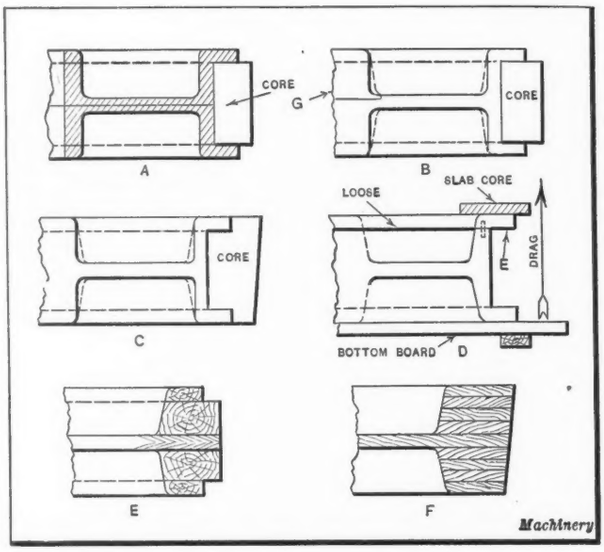


Fig. 2. Different Types of Patterns used in making Molds for Pulleys like the One shown in Fig. 1

pattern. The tapering sides of the hub and flange greatly facilitate the lifting of the cope. This construction, however, is not favored by many molders, who prefer to mold the pattern completely in the drag, with the exception of the ring section above the web and between the hub and rim which is molded in the cope.

At *C* is shown another method of constructing a pattern, which is considered excellent by some patternmakers. This is a one-piece pattern with no loose pieces in its construction. The hub and the rim are both made with considerable draft, as indicated by the dotted lines, which makes it possible to lift the ring of green sand with the cope without requiring any rapping of the pattern. The core-print is made flush with the top face of the pattern, and the side of the print is tapered to facilitate the lifting of the pattern and the accurate setting of the core.

Now let it be assumed that a pattern made as shown at *C* is received at the foundry and that the molder after looking it over decides that it could not be molded in green sand as the patternmaker had originally intended. It would not be necessary for the molder to return the pattern for alterations, as the ring sections of the cope could be molded by using a dry sand core. This would not necessarily require the construction of a core-print or a core-box. In this case the pattern is sent to the core maker and used in exactly the same way as a special core-box. Thus instead of an all green sand mold, a combination of green sand and dry sand core is used, which is often referred to by molders as a "flat back" cope. The dry sand ring core is placed in position on the flat back cope and securely fastened with wires. The wires are looped around a hook molded in the core, the ends being passed up through the cope. The ring is thus drawn tightly against the face of the cope and the wires securely fastened to a wooden bar laid across the face of the cope flask.

At *D* is shown still another construction, designed to be molded in a three-part flask consisting of a cope, cheek, and drag. Many molders, however, prefer to use a two-part mold when this type of pattern is employed. In the latter case, the whole pattern is molded in green sand and no cores are used. The ring *E* is loosely fastened to the wheel pattern. The first or drag mold is made with the pattern in the position shown, the sand being shoveled into the flask up to the top of the pattern. At this point the ring *E* is lifted from the mold and slab cores placed over the opening left by the removal of the loose ring. The filling in of the sand is then continued and the drag finished in the usual manner. The drag is next rolled over and the cope half of the pattern made. Two methods of building up patterns for flanged wheels are shown by the views at *E* and *F*.

Expanding and Contracting Ring Clutches

By ALBERT CLEGG

PROBABLY the simplest form of expanding ring clutch is that shown in Fig. 1, there being no adjustment for wear on this device other than a provision for increased expansion of the ring through a greater movement of the operating lever. The function of this clutch is to couple gear *B* to shaft *C*. Mounted on this shaft is a sleeve *D* on which is carried thimble *E* and friction ring *A*. In the enlarged end of the sleeve is a cylindrical plunger *F* which is tapered at the upper end *G* to fit between the similarly shaped ends of ring *A*. Plunger *F* is also slightly beveled at the lower end to match the taper of the sliding wedge *H*. Both friction surfaces are cast iron, and unless otherwise mentioned, are of this metal on all other clutches to be described.

To engage the clutch, the shipper or thimble *E* is forced over to the left, thus raising the plunger through wedge *H*, and expanding the friction ring *A* against gear *B*. Since there is no definite stop to prevent further sliding of the thimble and wedge toward the left, any wear which develops is simply taken care of by pushing the actuating lever further over, the wear being thus taken up more or less automatically. This type of clutch is used by some of the best machine tool builders, one prominent firm using it for the double back-gears of both lathes and milling machines.

Two or three objections to this clutch are advanced; however, as it has been in successful use for several years, it would seem that the objections are more apparent than real. In the first place, it has been said that since the force pushing out plunger *F* is one-sided and, therefore, unbalanced, it is almost inevitable that gear *B* will run more or less eccentrically when the clutch is engaged. In the second place, should there be much wear, the maximum expansive capacity will soon be reached, in which case a new ring will be required. In fairness it should be pointed out that the wear (of the friction surfaces at any rate) will be comparatively light if the friction surfaces are adequately proportioned for the service required. Another minor objection made is that the expanding mechanism does not give a progressively increasing leverage, as a result of which it is not possible to obtain the intense final pressure desirable. With the arrangement shown, the leverage can hardly be other than constant.

Fig. 2 shows a similar clutch, but with the expanding mechanism designed to give a progressively increasing leverage. Plunger *F* of this design is fitted with a roller at the lower end, and the upper face of wedge *H* instead of having a straight taper, is arc-shaped, merging into a parallel section. When the wedge first starts to move the plunger outward, the movement of the plunger is relatively large for a given horizontal movement of the wedge, but as the wedge approaches the end of its travel, the outward movement of the plunger becomes less and less, until finally the straight part of the wedge is brought under the roller, at which time all outward movement of the plunger ceases.

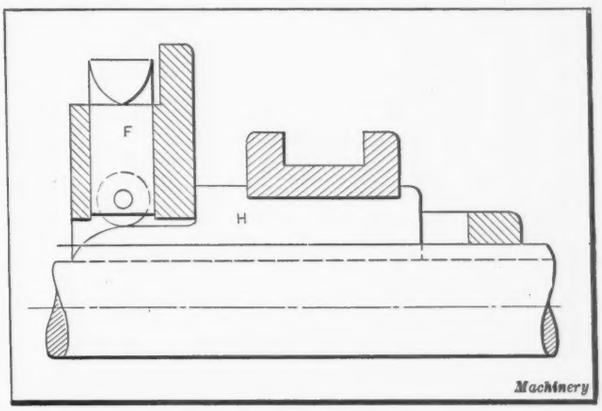


Fig. 2. Improved Expanding Mechanism for Clutch

The leverage of this mechanism is much greater at the moment of final engagement than that of the clutch in Fig. 1, but it should be noted that the self-adjusting feature of the clutch has been entirely lost. The wedge and thimble have a definite movement, and some other provision is necessary to take care of wear. Succeeding examples will illustrate various methods of securing the harmonic feature of a constantly increasing leverage, as well as independent adjustments for wear.

Expanding Ring Clutch with Unusual Adjustment

Another expanding ring clutch somewhat similar to the previous examples but having one or two important improvements, including an ingenious method of adjustment, is shown in Fig. 3. The clutch is used on turret lathes built by Alfred Herbert, Ltd., and is noted for power-transmitting capacity. The diameter of the friction surfaces is 4 inches, and the face width 1 inch, the clutch transmitting the full power of a 12-inch pulley driving a 5-inch belt and running at 500 revolutions per minute, which equals about 10 horsepower. The clutch is in the driving pulley, and is used to start, stop, and reverse the whole machine. Two clutches are used, side by side, one for the forward drive, and the other for the reverse.

The expansion of the ring is accomplished by a plunger, the same as in the previous examples, but the plunger is so arranged as to be readily increased in length for adjusting purposes. The method of pushing out the plunger is such that a harmonic motion results, with, at the same time, an equally balanced pressure on the ring. The ring is fitted with two rollers *C* so as to reduce the friction of plunger *H* when under pressure. The plunger is forced out by rod *D*, which

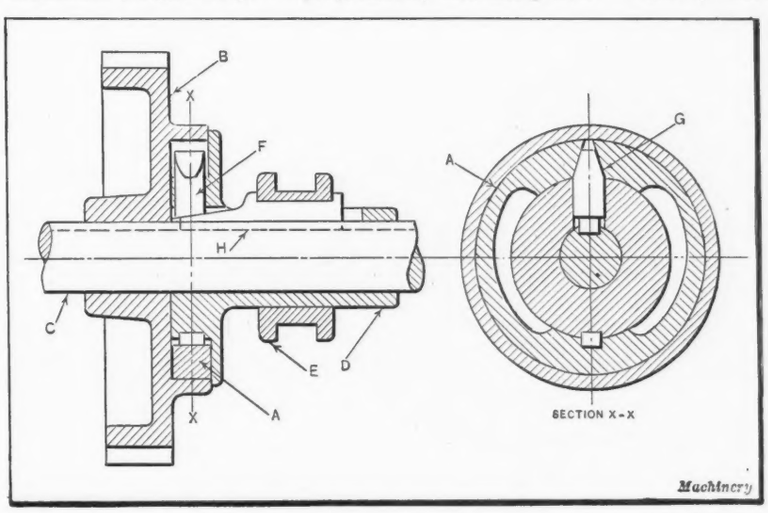


Fig. 1. Simple Type of Expanding Ring Clutch

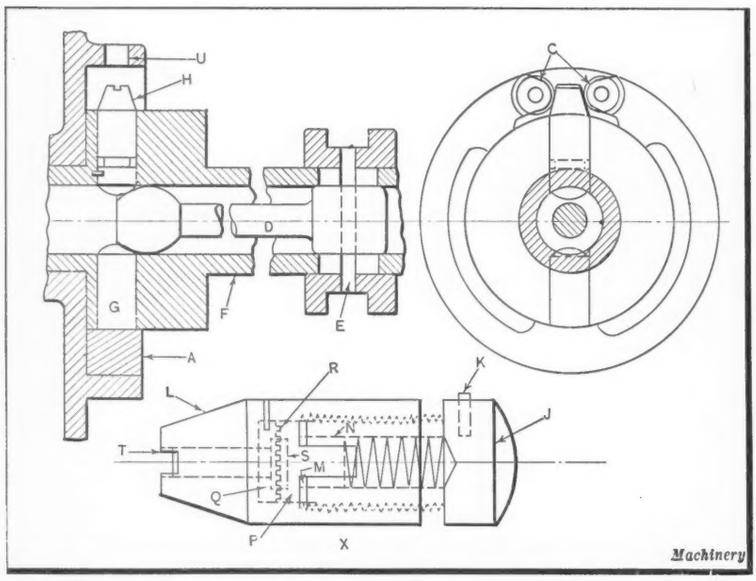


Fig. 3. Expanding Ring Clutch with Ingenious Adjustment to compensate for Wear

extends through the center of the hollow driving shaft *F*, the rod being connected to the actuating thimble by a transverse pin *E*. This pin passes through an elongated hole in the driving shaft. The left-hand end of rod *D* is approximately spherical in form, one half of the enlarged end operating one clutch, and the other half, the second clutch. The spherical head is a slack fit in the bore of the shaft. The shape of the enlarged end insures that the leverage will be progressive and that the clutch will be self-locking when engaged.

Diametrically opposite the main plunger *H* is a second plunger *G*, the inner end of which is shaped exactly like that of the main plunger. When the actuating rod is moved to the left the expanding pressure is equally divided between the two plungers *H* and *G*, thus preserving a balance and insuring that the clutch will be concentric. The main plunger *H* is of an interesting design, as will be seen from the enlarged view at *X*. The head of part *J* is rounded to provide easy contact with rod *D*, and a pin *K* prevents its turning in the enlarged end of the driving shaft. Part *L* of the plunger is hollow, and tapped to receive the lower section *J*. Part *J* has a comparatively deep transverse slot *M* in it, and is drilled up the center at *N* to receive a helical spring.

On the small cylindrical piece *P* there is milled a tongue to fit into the slot, and on the opposite end, fine-pitch clutch teeth *R*. The spring tends to force the cylindrical piece *P* outward away from head *J*. Fixed in the bottom of the hollow part *L* is a washer *Q*, which is also provided with clutch teeth to match those on part *P*. The pointed end of the plunger is bored out to receive a small stud *S* which presses against part *P*, the outer end of the stud projecting slightly from the bottom of a screwdriver slot *T* which is milled in the end of the plunger. The complete plunger is not more than 1 inch in diameter and less than 2½ inches in length.

To adjust the clutch, a screwdriver is inserted through a hole *U* in the outer friction ring, and stud *S* pressed down as far as it will go. This disconnects the toothed members *P* and *Q* and permits section *L* to be screwed out from part *J* as required, thus lengthening the plunger and increasing the amount of expansion of the friction ring. When the screwdriver is removed, member *P* is forced outward into engagement with part *Q* by the action of the spring, thus effectively locking the plunger and maintaining the required adjustment. The operation of adjusting the clutch does not take more than a minute or two, and once the adjustment is made, there is no possibility of its being disturbed except by wear.

Design Operated by Toggle Levers

One of the most popular forms of expanding ring clutches is the type shown in Fig. 4 in which the expansion of the rings is secured by a simple form of toggle joint, which gives a high opening pressure that progressively increases as the clutch is brought into engagement. Spindle *A* is driven by the clutch boss *B*, which is made solid with the flange B_1 and keyed to the spindle. The friction ring is secured on the same side of the flange as boss *B* by three studs *E*, which are firmly screwed or bolted into the plate but are a loose fit in the ring to permit the latter to expand freely. The open ends of the expanding ring are drilled and tapped to receive the two adjusting screws *G*, each of which is fitted with a lock-screw *J*. The inner end of the adjusting screws has a spherical seat to fit the end of the toggle levers *H*. The opposite end of the toggle levers is carried in a bushing *K* which is a sliding fit in a projecting lug *F* of shipper *C*. Shipper *C* is connected to the operating handle by the usual forked-lever arrangement, and it is slidably keyed to boss *B*.

In the side elevation, the full lines show the position of the toggle levers when the clutch is disengaged, while the dotted lines show the engaged positions. It will be seen that the leverage increases progressively until the moment of final engagement, when it reaches infinity, thus allowing a big expansive pressure with a comparatively small effort. The function of the sliding bushing *K* is to equalize the pressure on the two ends of the ring. Were this bushing fixed, the two adjusting screws would require a delicate adjustment, as otherwise there would be a greater pressure on one end than on the other and the shipper would tend to bind on its key.

When it is necessary to make an adjustment, the two lock-screws *J* are first loosened, after which a screwdriver is inserted through holes *Y* in the outer friction ring and each adjusting screw is turned approximately the same amount, until the required pressure is secured. This is judged by the "feel" of the operating handle. The lock-screws are then retightened, after which the clutch should operate for a long period before another adjustment, to equalize the pressure, is required.

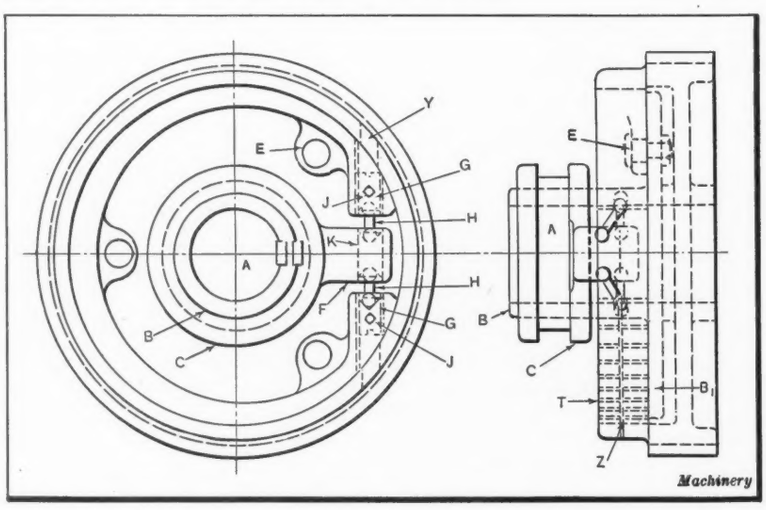


Fig. 4. Clutch in which the Expansion is accomplished through Toggle Levers

In machining the working surface of a ring similar to the one in the clutch just described, it should first be expanded an amount equal to the expansion when in use. If this is done and the friction surface then turned to size, there will be a much better chance of obtaining a proper fit between the male and female friction surfaces, as well as a more equalized pressure over the whole working surfaces. The ring itself should be made stiff enough to contract when the toggle levers are disengaged, and to remain contracted against the action of centrifugal force. From this point of view, the faster the clutch runs, the heavier the ring section should be. On the other hand, the lighter the section, the greater is the possibility of securing an equalized pressure. Therefore, it would appear to be best to provide some independent means of insuring the full contraction of the ring; for this purpose a spring could be fitted with little trouble or cost.

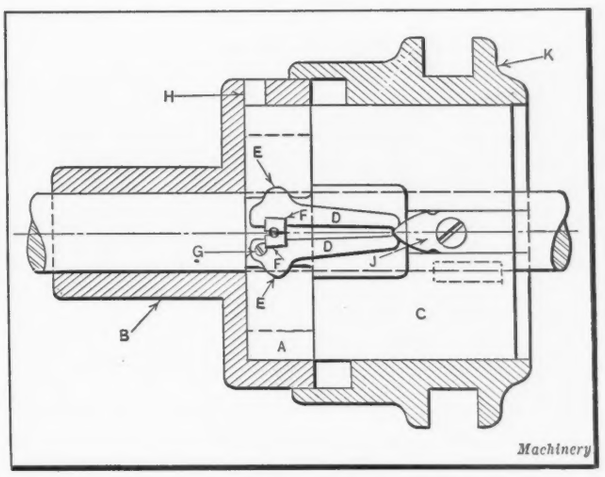


Fig. 5. Johnson Expanding Ring Clutch

There is another detail of friction clutch design which is well worth mentioning, particularly since it is claimed that by its adoption, a given clutch will transmit 25 per cent more power. This detail is the provision of circumferential and transverse grooves in the male friction surface, as indicated at *Z* and *T*, respectively. The effect of these grooves is to split up the friction surface into a number of comparatively small and separate sections. One claim is made that the interrupted surface has a much better chance of squeezing out oil and thus securing, in the least possible time, a metal-to-metal contact. On the other hand, it has been claimed that the grooving insures better lubrication.

It is not unreasonable to assume that both claims might be justified. When the clutch is engaged, the grooves undoubtedly assist in the more rapid removal of any oil that may adhere to either of the friction surfaces, while, on the other hand, they also act as carriers and distribute the oil over the friction surfaces as soon as the clutch is released. One of the largest British machine tool builders employs this construction, and claims that in addition to the increased power-transmitting capacity there is a corresponding increase in durability.

The Johnson Expanding Ring Clutch

One of the most widely used friction clutches designed primarily for light and medium duty at comparatively high speeds is made by the Carlyle-Johnson Machine Co., Manchester, Conn. This clutch is shown in Fig. 5; part *B* is the driving member on which is mounted the gear or pulley for the initial drive. It should be particularly noted that this clutch has no external projecting parts, which feature, together with the compactness, makes it suitable in practically every instance where a friction clutch might be required. It can be used equally well either with a totally enclosed all-gear drive or in the open for connecting up a driving pulley or gear. The clutch is made both in single and double designs, the latter being particularly suitable for reversing drives or two-speed gears. A two-speed or reversing friction clutch of this design, capable of transmitting 6 horsepower while running at 100 revolutions per minute, is 11 1/8 inches long and 6 11/16 inches in diameter.

It will be seen from the illustration that part *C* is fixed to the shaft by means of a key and set-screw, while sleeve *B* runs loose and carries the pulley or gear of the initial drive, as already mentioned. Friction ring *A* is loosely keyed to body *C*, and is expanded by two small levers *D*, which are rounded to fit arc-shaped seats *E* cut in the open ends of the friction ring. On the inner side of the levers, facing each other, are two small, hardened steel thrust blocks *F*. These blocks are doweled loosely together, and tapered on the outer sides where they fit into grooves in the levers. When the blocks are moved inward toward the center of the shaft, the two levers *D* are, in effect, made thicker, and the friction ring is consequently expanded.

The two levers are operated by wedge *J*, which is riveted to shipper *K* and slides in a groove in body *C* of the clutch. Incidentally, it should be noted that the shape of the wedge is such that a harmonic motion is given to levers *D* when the clutch is engaged, and it is almost impossible for the clutch to accidentally disengage itself. There is an adjustment by means of the small screw *G*, a hole *H* being drilled through the outer friction member to allow the insertion of a screwdriver.

The adjustment is very sensitive, a partial turn of the adjusting screw generally being all that is required to restore the original adjustment. A little care should be used to guard against over-adjustment, or too hard a setting up of the adjusting blocks. Since the internal leverage of the clutch expanding mechanism is high, the effort normally required to engage the clutch is comparatively slight. Any undue force necessarily means that the clutch is wrongly adjusted, and not working under the best conditions.

Contracting Ring Clutch

All clutches thus far described have depended on the principle of the expanding ring for their action. There are, however, some clutches in which this action is reversed, a ring being contracted on a male friction. Such an arrangement is shown in Fig. 6, the design being an inexpensive one used mainly on countershafts. The driving pulley *A* has a flange *Q* cast on one end, the periphery of which forms the male portion of the friction. Adjacent to this flange is body *B* of the clutch, which is secured to the shaft by means of a set-

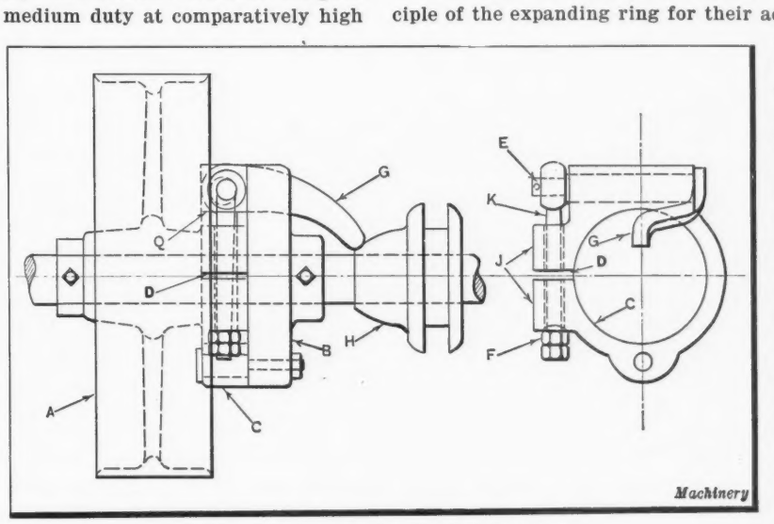


Fig. 6. Contracting Ring Clutch of Simple Design

screw or key, and to which is loosely fixed the friction ring *C*. This ring is split at *D* and has lugs *J* to receive the clamping and adjusting bolt *K*. On the lower end of this bolt there are two lock-nuts, one of which has a spherical face to fit into a spherical seat in the lower lug *J*.

On the upper end of the clamping bolt is an eye for attaching the eccentric end of shaft *E*. This shaft passes entirely through the upper part of the friction ring, and, at the rear, carries a lever *G*, which is bent sidewise so that its outer end comes approximately over the center of the shaft. Shipper *H* is shaped so as to give a progressively increasing leverage, and when it is moved toward the left, it pushes lever *G* up, and thus contracts the friction ring through the eccentric shaft and bolt *K*.

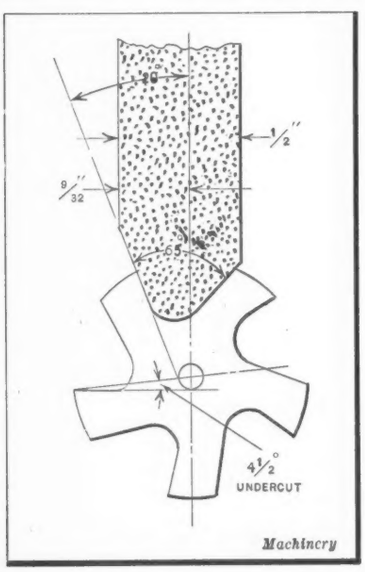
To adjust the clutch, the two lock-nuts *F* are tightened until the proper adjustment is obtained, after which the nuts are locked on each other to prevent displacement. It is not claimed that this clutch is a high-class design, as it is probable that the pressure on the friction ring is anything but equally distributed; however, it will give moderately satisfactory results in the comparatively light duty of countershaft driving.

* * *

GRINDING FLUTES OF STAYBOLT TAPS

By C. M. POND

The writer read with interest the article on page 551 of March MACHINERY entitled "Grinding Fixture for Staybolt Taps and Taper Bridge Reamers." It has always been the practice of the Pratt & Whitney Co., when regrinding staybolt taps, to sharpen the flutes of the tap as well as the outside of the thread and the reamer portion. A copy of the instructions for grinding staybolt taps which have been sent out to the various branch offices of the company for distribution among their customers, is given in the following, with the hope that this supplementary information will be of value to users of staybolt taps.



Method of grinding Flute in Staybolt Tap

1. In order to secure the best results, it is recommended that a grade 6646-M alundum wheel, 5 inches in diameter by ½-inch face, with a ¾-inch center hole, be used.

2. The wheel specified should be dressed with a carborundum brick, so that the contour will conform with the shape of the flute in the staybolt tap. To secure this result, a templet will be furnished representing the cross-section of a correctly fluted tap. A separate templet should be used for each diameter of tap.

3. The grinding wheel should be run at a speed of 4500 revolutions per minute, and the direction of rotation should be such that the sparks are thrown away from the operator.

4. When grinding the flutes, the staybolt tap is held by hand and brought in contact with the wheel at the pilot end. The tap should be moved under the wheel away from the operator until the end of the flute is reached. The operation is then repeated in the next flute and so on until all the flutes have been sharpened.

5. Care should be taken not to apply too great a pressure when grinding, as there is danger of drawing the temper to such an extent as to make the tap too soft in spots.

MONEY LOST BY FREE APPRAISAL SERVICE

By ERNEST F. DuBRUL, General Manager,
National Machine Tool Builders' Association, Cincinnati, Ohio

The value of appraisals for various purposes is becoming more and more recognized. The commendable practice of having an annual recheck so as to keep tab on depreciation and values is growing. Both in the first appraisal and in an annual recheck, the appraisers or the owners usually write to the builders of machinery asking for an estimate of the replacement cost. The requests generally come in around the first of the year, when the machinery manufacturer probably has much of his own work to do in getting up inventories, annual statements, tax returns, etc. Throwing the load of appraisal of users' machines on the machinery builder at an inconvenient time adds still more to the cost of having somebody get out this information.

It costs some money to look up old records, even those in the very best shape. Where the machine is of a special nature or is extremely old, the drawings and other data have to be dug out of old files. Unless properly made, the estimate is not worth anything at all. It requires sound judgment to make sound estimates of replacement costs, so that the work cannot be left to an office boy. The increasing frequency of requests for appraisals raises the following questions of interest to all machine builders, and all users of machines:

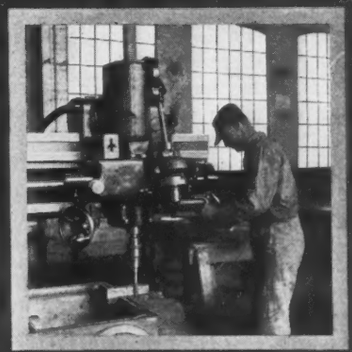
1. How much does it cost the machinery manufacturer to furnish the information?
2. Was such service and cost contemplated at the time of the sale of the machine, and was it included in the price?
3. If not contemplated and not included, who should pay the cost of getting the information?
4. If the user refuses to pay the builder for this extra service, can the builder be blamed for not giving the appraisal the attention it deserves?
5. In such cases is the appraisal likely to be worth much?
6. If it costs more through stopping of other work for the user to get this information out at the crowded first of the year period, should not the charge be greater at that time than at other times in the year when it is not so inconvenient and costly?

In most cases the service and cost were not contemplated at the time of the sale of the machine, nor was any allowance made in the price, as all users of machines do not require appraisals, and all those getting appraisals do not have an annual recheck. It would appear to be fair that those desiring the service should pay a reasonable price for it. Legitimate appraisal companies recognize that the manufacturer of the machine should be paid for this service, and they pass the cost on to the client, where it properly belongs.

Investigation shows a growing appreciation of the fact that appraisal is a growing burden on any builder of machinery, so there is a growing custom of charging for the work. The most common charge acceptable to the appraisers seems to be $1 to $3 per item. In some cases the charge depends on the list submitted and the time taken to look up data on the whole list. A practice of charging for this service seems to be well on the way of general establishment.

Some machinery manufacturers report that occasionally customers object to a charge. There are no reasonable grounds for such objection, but machinery builders have furnished free service of this kind through fear of losing the customer's good will. In effect, the cost of free service to some customers will, of course, eventually come into the overhead. This means that customers buying new machines, and particularly those who do not expect or ask for appraisal service, will pay the cost of rendered service to those who had previously purchased machines. This is manifestly not the proper way to allocate this burden, as any fair-minded person will agree.

Letters on Practical Subjects



DOUBLE-END MILLING FIXTURE

It is sometimes convenient to perform two milling operations in the same fixture, and thus save time by eliminating the necessity for transferring the parts from one machine to another. The double-end milling fixture here illustrated was designed for a case of this kind. It holds eight pieces, four pieces being held at each end of the fixture by means of clamping screws *D*.

The work is located on plugs such as the ones shown at *G*, *H*, and *L*. The first machining operation is performed with the work held on the locating plugs *G* and *H* and the intermediate plugs that are located in between the broken ends of this section of the fixture. After the first milling cut is taken, the work is transferred to the plugs on the right-hand end of the fixture, the first plug being that shown at *L*. The locating plugs *G* and *R* are fitted in elongated holes in the cast-iron base *A*, and are held in place by washers *M* and nuts *N*. The locating plugs *H* and *L* are driven into the base *A*, as it is not necessary that these members be moved for loading and unloading the work.

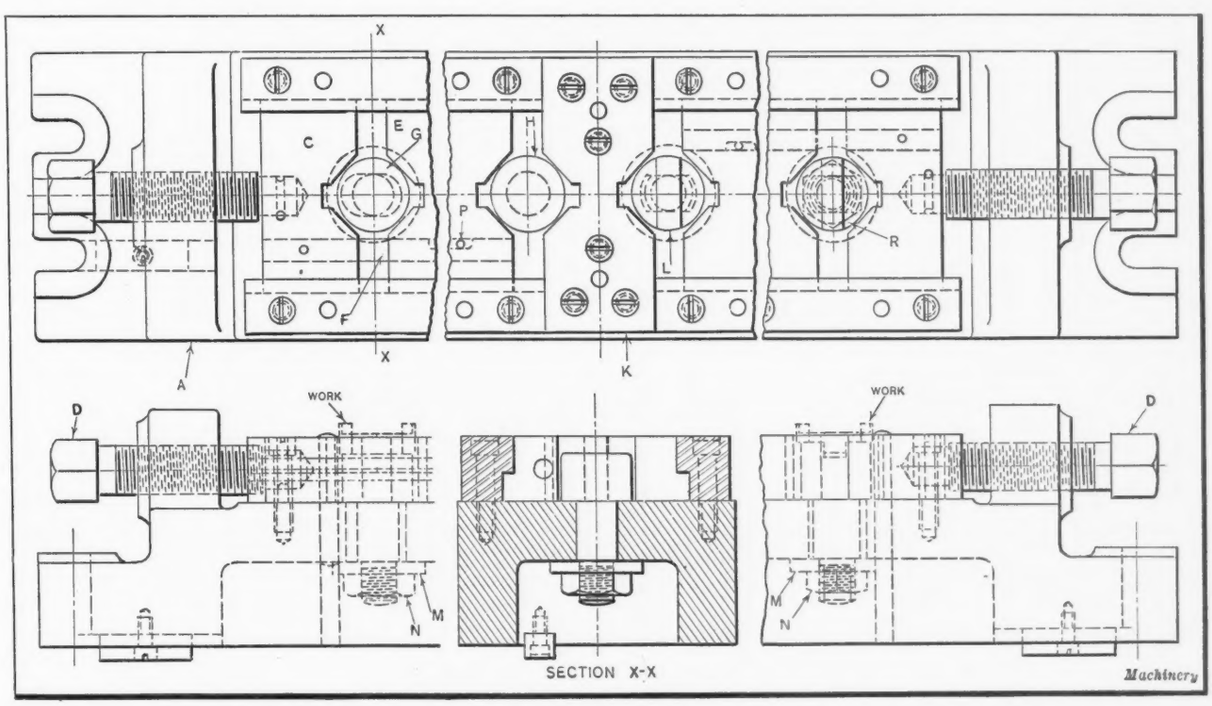
The V-block *K* is rigidly held in place on base *A* by screws and dowels. The V-blocks *C* and *E* are connected by bar *F*. This bar is a drive fit in the V-block *C*, and is secured to this member by a dowel-pin, but is a slip fit in the notches in the other V-blocks. When loosening the clamping screw *D*, bar *F* is moved outward until the notches cut in its side come in contact with pins like the one shown at *P*. The V-blocks cause the locating plugs *G* and *L* to move in the elongated holes. This construction causes the work to be released in the fixture when the clamping screw *D* is loosened.

Connersville, Ind. D. D. WELLS

AN AUTOMATIC REMINDER OF THINGS TO BE DONE

A good memory is a priceless possession, but few of us have memories that are infallible. The busy foreman or superintendent who does not have the services of a competent clerk to relieve his memory of a part of its burden, will find the following system of much value in bringing important matters to his attention at the proper time. The first essential is a set of index cards numbered from 1 to 31, corresponding to the days of the month. These may be kept in any convenient box or filing case. Any item of importance that requires attention at a later date is recorded on a small card or slip of paper, and placed in the file, back of the card bearing the numeral corresponding to the date decided upon.

At a certain time each day, all the slips for that date are taken from the file, and each item is given the attention it requires. When an item is disposed of, the slip is destroyed. If it happens that certain items cannot be taken care of on that particular date, the slips are replaced in the file



Double-end Milling Fixture for holding Eight Pieces of Work while Two Milling Operations are being performed

for a later date. Each item is thus carried on until its final disposition removes it from the file. It may also be convenient to have a similar file corresponding to the months of the year. This will be used in the same way, and at the beginning of each month, all the slips for that month are taken out and distributed through the date file. The principal advantage of this system over the ordinary desk calendar is that there are often items that must be carried over after they have been dated up. With the desk calendar, this means recopying, while with the card system, it simply requires shifting of the cards.

St. Louis, Mo. P. H. WHITE

METHOD OF MOLDING A DRUM-SHAPED PART

Recently while in a large foundry engaged in general jobbing work, the writer's attention was directed to a pattern which had just been received and from which molds for two castings were to be produced. The castings were required in the construction of a special winding drum and were of the shape shown in Fig. 1. The broken sectional view at the left-hand side of the vertical center line in Fig. 2 shows the construction of the pattern which was sent to the foundry. The workmanship on this pattern was excellent, but the design was such that a satisfactory mold could not be obtained until the pattern had been redesigned or changed as shown in the broken sectional view at the right-hand side of the vertical line. With the pattern design shown at the left-hand side of the vertical center line, it was necessary to provide core-prints *A* and *B*.

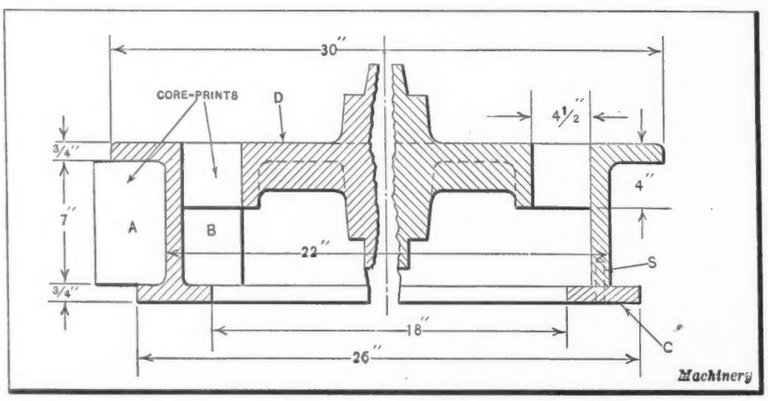


Fig. 2. Diagram showing Original and Improved Pattern Construction

Owing to the large size of the pattern and the thickness of the core-print *A*, drum *D*, and print *B*, which form the ring section of the pattern, it was considered a waste of lumber to make a solid pattern. The ring section including the core-prints *A* and *B* and the drum *D* was therefore built up in segment courses, box fashion, the outer and inner surfaces being segments of cylindrical formed pieces. Core-boxes were, of course, furnished for the cores *A* and *B*.

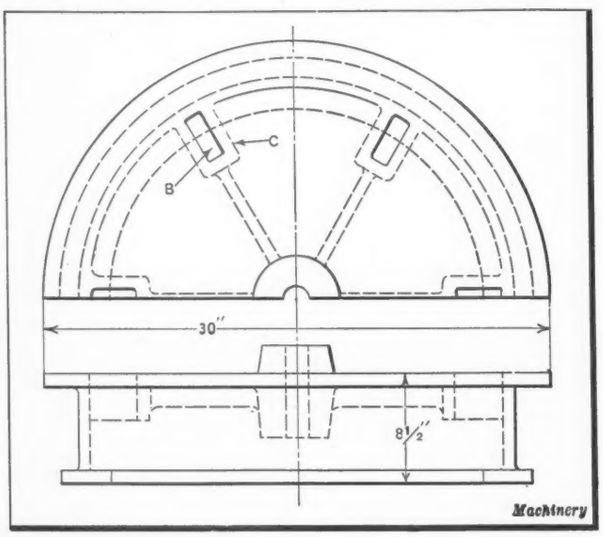


Fig. 1. Casting used in constructing a Special Winding Drum

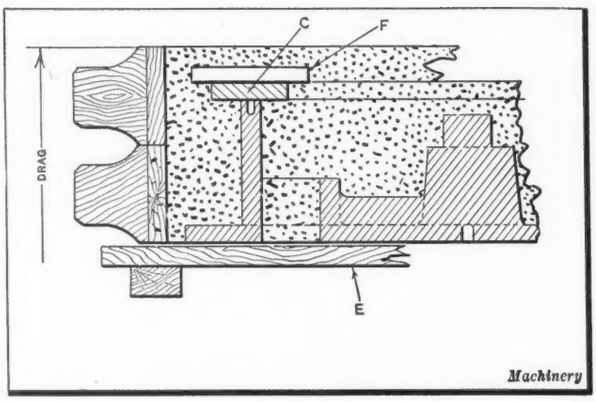


Fig. 3. Method of molding the Part shown in Fig. 1

Although these core-boxes were very carefully and accurately constructed and great care was taken to locate the cores in the mold, it was found impossible to produce a casting in which the cored holes *B*, Fig. 1, would register or be properly centered in the enlarged section *C* of the radial ribs.

The pattern as redesigned and used to produce a satisfactory mold, is the same shape as the casting desired. The flange *C*, Fig. 2, is made loose on the pattern, being located by dowel-pins *S*. The method of molding this pattern is shown quite clearly in Fig. 3. The pattern is placed on a bottom board *E*, and the molding sand filled in and struck off on a level with the upper surface of the loose ring flange *C*. Ring *C* is next removed, and a cover core *F* made up of several segments is placed over the cavity left by the removal of the loose piece. After the cover cores have been carefully located, molding sand is filled in and struck off on a level with the upper edge of the drag flask. The flask is then rolled over and the cope flask put in place. The mold is then completed in the usual manner, the cope being removed for the withdrawal of the pattern in the usual way.

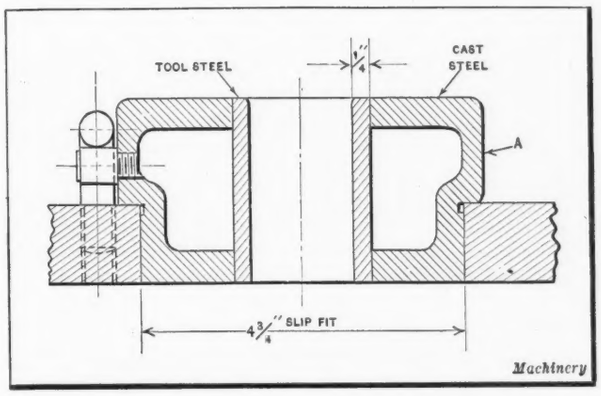
Kenosha, Wis. M. E. DUGGAN

INTERCHANGEABLE DRILL BUSHINGS

In designing a drill jig to handle a number of different pieces of the same type, it was found necessary to provide quite a variety of interchangeable bushings. All the bushings were required to have an outside diameter of 4¾ inches, as a bushing of this size was needed for the largest reamer used.

As the drills and reamers ranged from 1¼ to 3¾ inches in diameter, the bushings for the smaller sizes would, if made solid, have very thick walls and contain an excessive amount of high-priced tool steel. To overcome this objection, a set of bushings having walls of the usual thickness were made up for the smaller sizes, and steel castings like the one shown at *A* in the illustration were used to hold the steel bushings. The castings were all made from one pattern, and the cored hole bored out to fit the drill bushings. Bushings made up in this way were provided for all reamers and drills ranging in size from 1¼ to 2¾ inches in diameter.

The bushings were held in place in the jig by a pin and an L-shaped stud, as shown at the left-hand side of the cast-



Holder for Small Bushings, made from Steel Castings

steel bushing-holder. As quite a number of bushings were required, the cost of the cast-steel holders was small, compared with the cost of the steel that would have been used if all the bushings had been made of tool steel.

Beloit, Wis. H. F. RUEHL

INCREASING THE ACCURACY OF SLIDE-RULE CALCULATIONS

In the following, the writer has reference to the 20-inch polyphase rule, although the principle is applicable to slide-rules of any length, whether polyphase or not. While the 10-inch rule is more commonly used than the 20-inch rule the former is practically limited to checking, whereas the latter can be depended upon for accurate results, especially if we take advantage of a few "tricks of the trade."

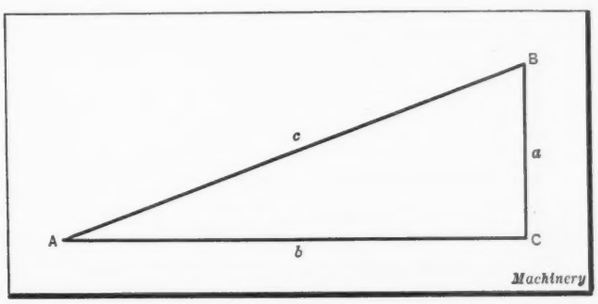


Diagram used to illustrate Slide-rule Problem

For those who are not familiar with the polyphase rule, it may be said that one of its principal advantages is that the lower scale can be used for practically all calculations whereas on a rule without this feature the upper scale has to be used more frequently and as this has divisions only half those of the lower scale, the results are not nearly so accurate. Another decided advantage of the polyphase rule is that, with but very few exceptions, three numbers can be multiplied with only one setting of the slide. In performing this operation, if three numbers are to be multiplied such as 165 × 917 × 253, it makes no difference which one is taken first, for if the operation can be performed with one combination, it can be performed with all, and the converse is also true. Still another advantage of the polyphase rule is that two numbers may with but few exceptions, be multiplied and the result divided by a third number with only one movement of the slide. The operations must be performed in the order named, as otherwise, two movements of the slide will be required.

The slide-rule is used extensively in the solution of triangles, and some applications along this line are described in the following: In the triangle shown in the accompanying illustration, let $A = 20$ degrees and $b = 2.6587$ inches. Now to find c, we multiply b by the secant of 20 degrees which equals $2.6587 \times 1.0642 = 2.82939$. To perform this operation on the slide-rule with the numbers as they stand, we read 2.829, but this is not close enough, as the majority of engineers work to four decimals, except when they are dealing with long distances. Let us think of 1.0642 as $1 + 0.0642$ and express the problem in the form $(2.6587 \times 1) + (2.6587 \times 0.0642)$. The value of the first quantity is evident. Multiplying the figures in the second parentheses, by means of the slide-rule, we obtain 0.1707. Then $2.6587 + 0.1707 = 2.8294$. The accuracy of this result may be checked by comparing it with the figures obtained by arithmetical computation. If this is done it will be noted that the error is only 0.00001 inch.

Referring again to the triangle, let it be required to find b, having given $A = 20$ degrees and $c = 2.8294$ inches. Then $b = c \times \cos 20$ degrees $= 2.8294 \times 0.93969$. Now the cosine equals 1 minus the versine, therefore if we multiply by the versine instead of the cosine, and subtract the result from the first number, the same final result will be obtained. The problem is then $2.8294 - (2.8294 \times 0.06031)$. Multiplying the two numbers in the parentheses, we read 0.1707, and subtracting, the result 2.6587 is obtained.

In the case of division, we have for example, sec $A = \frac{2.8294}{2.6587}$. The first figure of the quotient which is 1, is obtained by inspection or actual division on paper, and then 0.1707 is divided by 2.6587 on the slide-rule, which gives the remaining four figures as 0.0642.

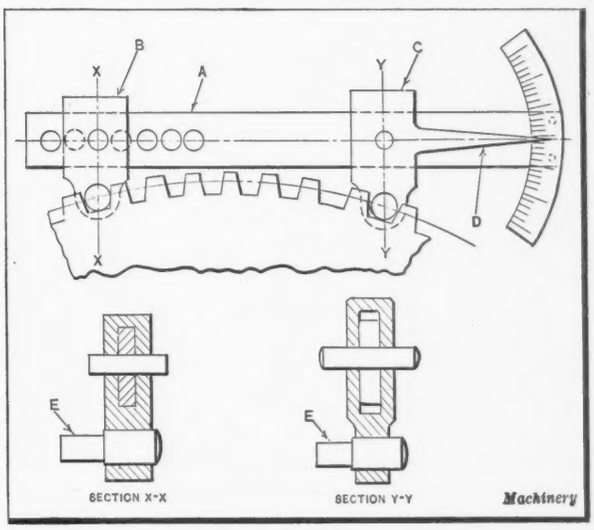
By using the slide-rule as described, much tiresome calculating is eliminated and considerable time is saved.

Toronto, Ontario, Canada CLIFFORD CORNWALL

MEASURING VARIATIONS IN THE PITCH OF GEAR TEETH

There has recently been a demand for gears of unusual accuracy for use in machines employed in the production of duplicate parts for automobile engines. One of the most important requirements is that the pitch of the teeth be uniform and accurate within very close limits. These requirements have caused various manufacturers to give considerable attention to the development of improved gages for testing the accuracy of gear teeth. The measurement of the depth and thickness of a single tooth can be readily accomplished with available tools, the most commonly used measuring tool being the gear tooth micrometer.

The spacing of gear teeth is generally done by subdividing the entire circle with the usual indexing mechanism of the gear-cutter. However, in many instances, the driving gears of this indexing mechanism are not sufficiently accurate to meet the most exacting requirements, and while they may



Device for measuring Variations in Pitch of Gear

register quite accurately at the completion of the circle of 360 degrees, it has been found that the individual spacing of the teeth often varies perceptibly. A gear with teeth of unequal spacing cannot, of course, be used in another machine which is required to produce extremely accurate results, as the error in spacing would be multiplied.

The device shown in the accompanying illustration was designed to provide a simple means of testing the spacing of groups of gear teeth. This tool consists of a bar *A*, a movable head *B*, and a fixed head *C*, with an indicating arm *D*. Both of these heads are fitted with cylindrical steel jaws *E*, the diameter of which is carefully worked out to suit the gears to be tested. Usually two sets of jaws is all that is necessary to meet the requirements of any individual shop. When in use, this tool measures or tests the pitch of a group of eight or ten teeth, and is stepped around the gear in corresponding groups. The amount of variation in the various groups is shown by the gage, and where limits are established the imperfect gears are quickly detected.

Washington, D. C. G. A. LUERS

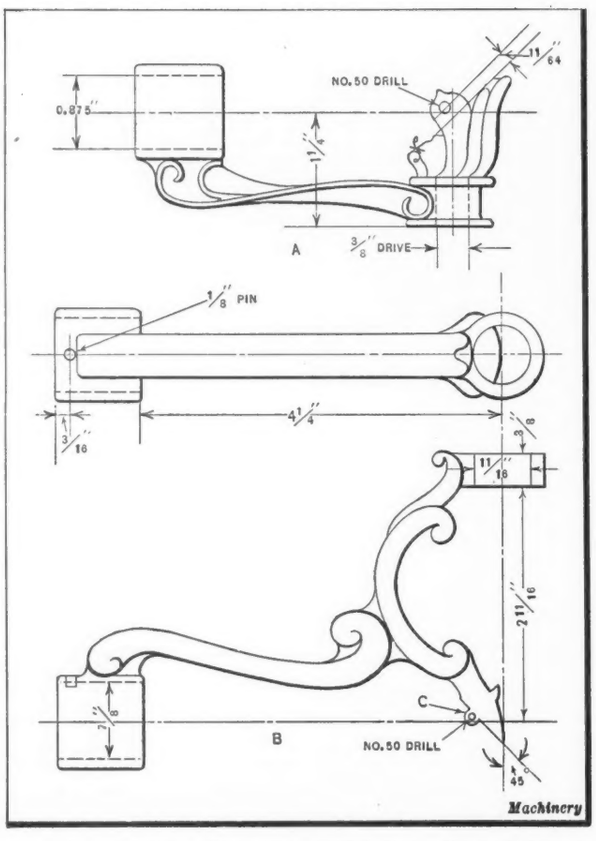


Fig. 1. Slender Castings requiring Drill Jigs of Matrix Type

MATRIX JIGS FOR SLENDER CASTINGS

Slender ornamental castings, such as shown in Fig. 1, cannot be readily held in jigs of the usual or conventional types. The castings for the two forms of prism-holders for a reflecting telescope, which are shown in this illustration, are required to be machined very accurately. Regulation jigs were provided for these parts, but they proved unsatisfactory and were finally replaced with "matrix jigs." The matrix jig used to hold the casting *A*, Fig. 1, is shown in Fig. 4. As there appears to be no mention of fixtures of this type in recently published books on jig design, a brief description of the procedure followed in making these jigs may be of value to mechanics and designers.

In Fig. 2 is shown a set-up on a Van Norman miller, which is the first step in obtaining a correctly machined casting of the type shown at *B*, Fig. 1, from which a plaster cast can be made. The plaster cast is used as a pattern for the pair of vise jaws which constitute the matrix jig for this part. It will be noted that this casting is of such a shape that both holes must be bored from the ends or from the sides opposite the prism seat at *C*, since this seat extends to the point of intersection of the axis of the two holes, and therefore prevents drilling from that end.

In this case it was impracticable to bore either of the holes in an engine lathe, except by employing an elaborate clamping arrangement on the lathe faceplate. The specially arranged chuck which grips the work on the parts that require machining is a common three-jaw scroll chuck having a rather large bore. This chuck is bolted to a circular plate so that it can be swiveled on the milling machine table. It will be noted that the boring tool enters the work from the rear side of the chuck, and that the arm of the casting is located between two of the vise jaws, while the hub is securely gripped well back toward the rear end of the jaws.

The boring tool consists of a fly-cutter bar held in a Jacobs drill chuck. The opposite end of the casting projects from the faceplate and does not interfere with any of the machine parts. It is also conveniently located for gaging or testing as the work progresses. Both faces of the 11/16-inch hole are faced without removing the work from the chuck. The ⅞-inch hole is bored and faced in the same manner, care being taken to see that this hole is machined in the correct relationship to the 11/16-inch hole.

In Fig. 4 is shown the completed matrix jig for holding the casting *A*, Fig. 1. This jig consists of three parts—two jaws *D* and *E*, and a plate *F*. Plate *F* is doweled to the

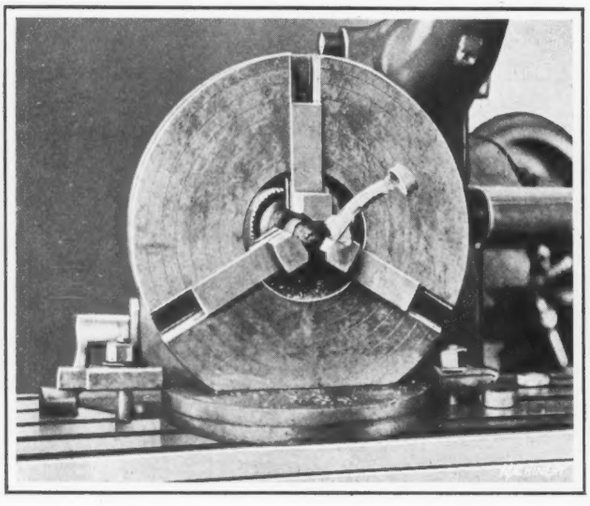


Fig. 2. Milling Machine Set-up for boring Hole in Casting

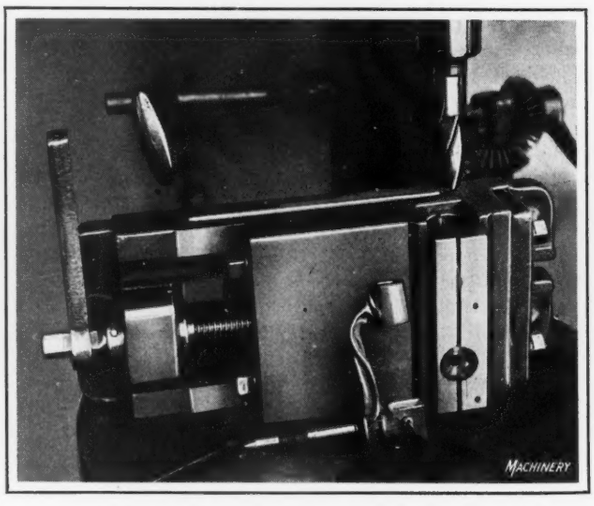


Fig. 3. View showing Method of holding Matrix Jig in Vise

locating jaw *E*. The hole through the plate serves to guide the drill, when drilling the smaller of the two holes in the casting. Both halves of the jig are machined on all outer surfaces while one of the castings is in position between them. Care is taken to finish two surfaces of one of the pair of jaws so that they will be parallel with the holes that are to be drilled or bored in the prism-holder. This insures locating the work accurately when the jaws are held in a vise in the manner shown in Fig. 3. The jaw *D*, Fig. 4, is made somewhat smaller in width and length than jaw *E*, so that the latter jaw will always be the one that determines the location of the jig in the vise. Any slight variation in the casting will not affect the accuracy of the product to any appreciable degree.

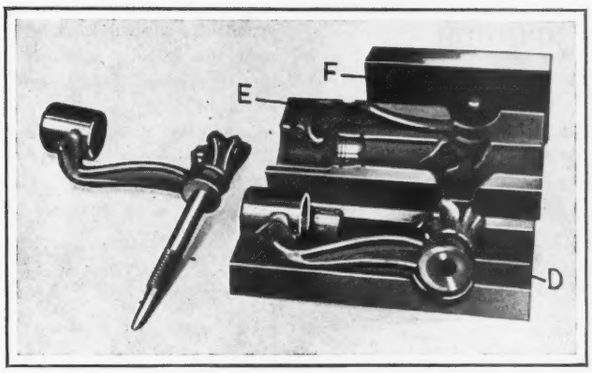


Fig. 4. Matrix Jig used to hold Casting shown at A, Fig. 1

One hole is drilled with the vise lying horizontally on a two-spindle drilling machine, the jaws of the jig being held against the bottom face of the vise. For the second drilling operation, the vise is bolted against a properly aligned angle-iron, as shown in Fig. 3, which is firmly bolted to the platen after having been carefully centered from a finished part held between the matrix jaws. As the ⅞-inch hole is cored, two square-end drills are used, one for roughing and the other for finishing. The lands of the finishing drill are relieved the same as a reamer, so that an excellent finish is obtained. The seat for the prism is readily machined by holding and locating the castings from the two finished holes, a special fixture being employed for this operation.

Springfield, Vt. O. S. MARSHALL

FORMULA FOR CALCULATING PROFILE GAGE ANGLES

In making profile gages for outlines such as shown in the accompanying illustration, it is always desirable first to calculate the angle *E*. This angle can then be used in setting up the gage for grinding or other operations. Usually the radii *A* and *B*, the horizontal center distance *C*, and the vertical center distance *D* are given. The angle *E* must then be computed from the known dimensions.

The problem involves one of four cases as follows: Case 1, in which the radii *A* and *B* are equal; Case 2, where one radius is greater than the other, and the centers *H* and *G* are located on the same horizontal line; Case 3, in which the radii are unequal, and the centers *H* and *G* are not located on the same horizontal line, *H* being higher than *G*; and Case 4, where the radii are unequal, and the centers *H* and *G* are not in line, *G* being higher than *H*.

For Case 1 angle E = angle F and $\tan F = D \div C$.

Now in Case 2, dimension $I = B - A$ and angle E = angle F. We also have $\sin F = I \div C = (B - A) \div C$.

In Case 3, we have angle F = angle E = angle J − angle K and $HG = \sqrt{C^2 + D^2}$. We also have $\sin J = I \div \sqrt{C^2 + D^2}$ and $I = B - A$. Now as $\tan K = D \div C$, we have angle E = an angle whose sine equals $(B - A) \div \sqrt{C^2 + D^2}$ minus an angle whose tangent $= D \div C$.

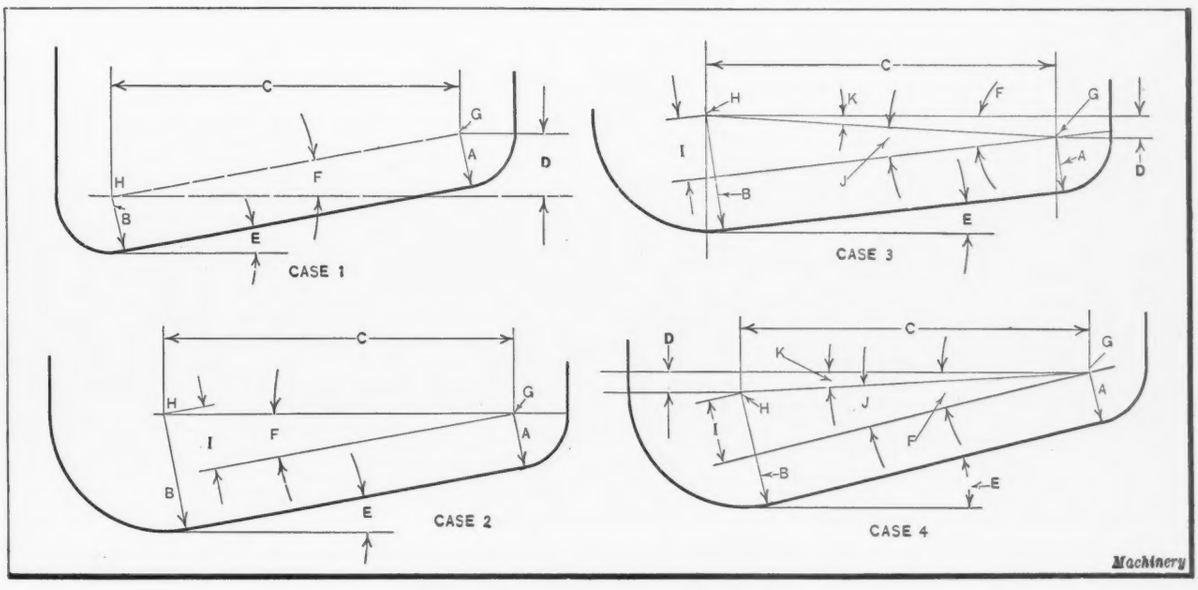
For Case 4 we have angle E = angle F = $J + K$. Sin $J = I \div HG = (B - A) \div \sqrt{C^2 + D^2}$, and $\tan K = D \div C$. Thus we have angle E = an angle whose sine equals $(B - A) \div \sqrt{C^2 + D^2}$ + an angle whose tangent equals $D \div C$.

From the foregoing equations we can develop a general formula that may be applied to all four cases. This formula may be written:

$$E = \sin^{-1} \frac{B - A}{\sqrt{C^2 + D^2}} \pm \tan^{-1} \frac{D}{C}$$

Expressed in words, angle E equals an angle whose sine equals $(B - A) \div \sqrt{C^2 + D^2}$ plus or minus an angle whose tangent equals $D \div C$. With this rule it is only necessary to remember that when point *G* is higher than point *H* we add the first term to the second term, while when point *G* is lower, we subtract the second term from the first. The other variations will be taken care of by the conditions of the problem itself. For instance, in Case 1 we have $B - A = 0$; hence the first term will be automatically dropped from the formula. In Case 2, $D = O$, and therefore the second term will be eliminated. While in the other two case the plus or minus sign will take care of the conditions, as previously explained.

Cleveland, Ohio EDWARD HELLER

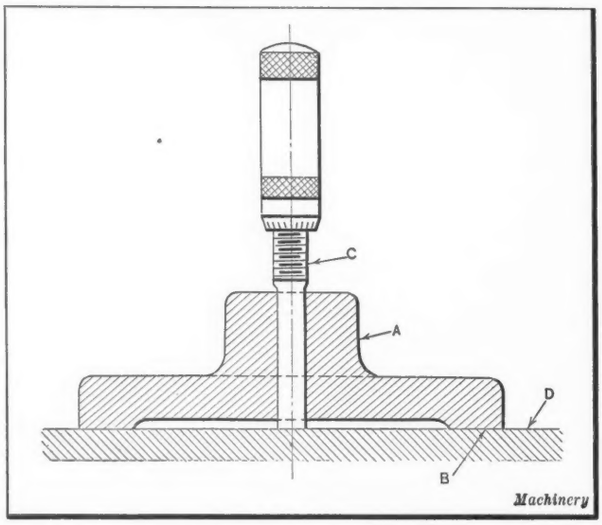


Diagrams used in calculating Profile Gage Angles

A FIXTURE FOR RESURFACING MICROMETER SPINDLE

In October MACHINERY, page 146, there appeared an article entitled "Fixture for Truing Micrometer Spindle Contact Surface." While the fixture and method there described are practical, the fixture shown in the accompanying illustration is much simpler. It provides a means of holding the micrometer spindle perpendicular to the trued surface of a cast-iron plate *D* which is charged with fine emery and oil. The flange-shaped fixture *A* may be made of any suitable piece of scrap iron. It has a central hole bored to a good sliding fit for the micrometer spindle. The narrow ring *B* is faced off square with the bored hole.

It is best to bore the hole and face the ring *B* at one setting of the work in the chuck, although the facing operation can be performed after the hole is bored, by mounting the fixture on a true-running arbor held between lathe centers. The micrometer spindle *C* is inserted in the hole and pushed down level with the faced end of the fixture. By moving the fixture to and fro on the charged plate *D*, the end of the micrometer spindle will be lapped square.



Method of resurfacing Micrometer Spindle

A good way to check the accuracy of the fixture is to turn the micrometer spindle one-half of a revolution in the fixture after it has been lapped as described and then move the fixture to and fro on the plate several times. An examination of the spindle face will then determine if the fixture is accurate.

Saginaw, Mich. GEORGE W. MCCANDLESS

PORTABLE CRANKPIN TURNING DEVICE

An inexpensive and easily constructed hand-operated device for turning the crankpins of small side-crank engines is shown in the accompanying illustration. Its capacity, if made according to the dimensions shown, is for pins from 1¾ to about 4 inches in diameter. Thus it is suitable for engines having cylinders from 7 to 16 inches in diameter. The tool is small and compact and can be easily taken to the job.

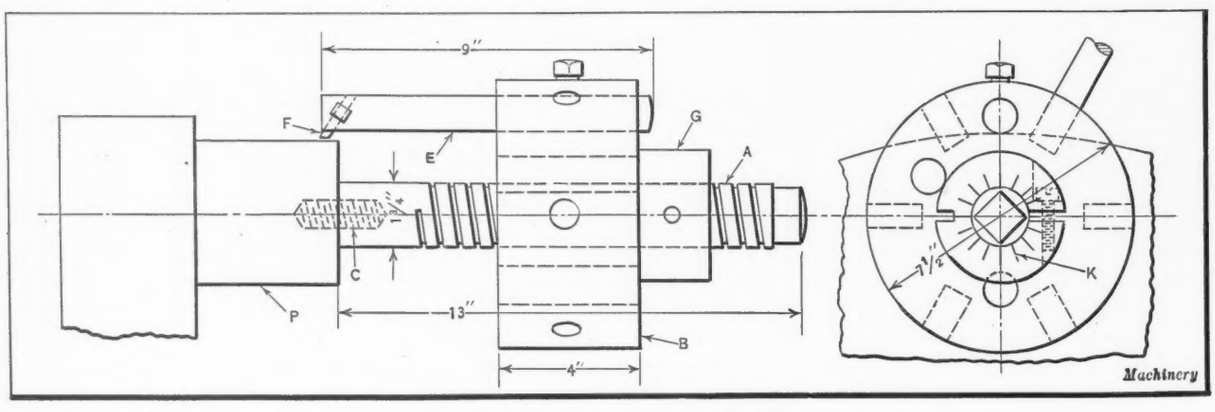
There are only two principal parts—the shaft or spindle *A* and the cutter-head *B*. A thread having a pitch of ½ inch but a width of only ⅛ inch is cut on the spindle *A*. This leaves a land ⅜ inch wide on the threaded spindle which forms the support for the head *B*. One end of the spindle is tapped to receive the stud *C* which serves to connect the spindle to the pin *P* that is to be turned. Studs having threads of different sizes can be provided for use on different engines. The right-hand end of the spindle *A* is squared so that a wrench can be used to tighten the spindle on the crankpin.

The head *B* is made of cast iron, and may be solid or split in such a way as to provide means of adjusting to compensate for wear. The writer recommends, however, that it be made solid and carefully fitted to the spindle. Six 13/16-inch holes are drilled in the periphery of the head to receive the pin that is used as a means of revolving this member when performing the turning operation. Other holes are drilled through the head which are a close fit for the tool-holder *E*. This holder is 1 inch in diameter, and is slotted at one end for the turning tool *F*. The slot for the turning tool is cut at such an angle that the point of the tool is located beyond the end of the holder. Referring to the view at the right-hand side of the illustration, it will be noted that the various holes for the holder *E* are located at different distances from the center of the spindle *A*. This feature provides a means of locating the holder *E* as close as possible to the surface to be turned.

The feed-nut *G* is made of cast iron or brass; the latter material, being much easier to work, is perhaps preferable. This nut is threaded to fit the spindle and is split on one side so that it may be adjusted to fit the spindle just tight enough to prevent the friction between the head *B* and the face of the nut from causing the latter to advance when the head is rotated. Several holes are drilled in nut *G* for the reception of a small spanner wrench which is employed for feeding.

The amount of feed depends on the depth of the cut. A very fine feed will, of course, produce the smoothest surface, and for that reason is desirable. If sixteen divisions are made on the face of nut *G*, as shown at *K*, they will be of great assistance in obtaining a uniform feed movement. A line, drawn the length of the spindle, is used in connection with the division lines on the face of the nut. By turning the nut one division, a feed of 1/32 inch will be obtained. Finer feeds may be accurately gaged by turning the nut a fractional part of a division.

Memphis, Tenn. JAMES ELLIS



Hand-operated Device for turning Crankpins

New Machinery and Tools

The Complete Monthly Record of New Metal-working Machinery

New Britain "New-Matic" Chucking Machine

A MULTIPLE-SPINDLE chucking machine of the work-rotating type has been developed by the New Britain Machine Co., New Britain, Conn., primarily for machining forgings and castings on which facing and forming operations are required in addition to drilling and reaming. This machine has proved to be especially adapted to finishing ball races, gear blanks, etc. One of the principal features of the machine, which is known as the "New-Matic," is an air control operated by a single valve each time a work-spindle is indexed into the loading position. The control disengages the drive to that particular spindle, applies a brake to stop the spindle rotation quickly, and actuates the clutch mechanism to release the work. When the chuck has been reloaded, the air valve is operated a second time to grip the jaws on the work, release the brake, and engage the drive to the spindle. In each case, these operations, in sequence, follow a single movement of the air valve. This air control relieves the operator of the manual labor of hand chucking. Because of combining the movements necessary for operating the chuck with those for starting and stopping the machine, one man can tend two machines.

The operator has considerable time in which to chuck the piece without delaying the output, as the time in which the spindle is stopped and started is within his control and not mechanically timed with any other function of the machine. He stops and starts the spindle at will while it is in the loading position, and has a chance to determine whether the work is rotating approximately true and rechuck it if necessary, before the tools engage it. Normally the operation of the machine continues if the operator keeps step with the fixed rate of production, but in case the operator is delayed beyond the index time, a safety device comes into play to prevent indexing until the operator throws in the feeding clutch. For cases where it is not advantageous to use the air control in connection with the chucking, the machine is equipped with hand-operated chucks, collets, or fixtures.

The machine is built in two sizes, weighing 10,500 and 7500 pounds, respectively, and each size can be equipped with either four or six work-spindles accommodating work up to 8 inches in diameter, depending upon the operations to be performed. On a four-spindle machine there are four tool stations on the longitudinal tool-slide, one station on the front cross-slide, and two stations on the rear cross-slide. The tools on the cross-slides may be used separately from those on the longitudinal slide, or in conjunction with them as, for instance, in rocking a recessing tool mounted on the longitudinal slide into the work after it has been fed to depth. The tooling arrangement provides for machining work in three spindle chucks while reloading work in the fourth. (In some instances work can be machined in the fourth position after loading). The spindles may be equipped with contracting chucks for gripping the work externally, and expanding chucks for gripping internally. Should the character of work require hand-operated chucks, the air control is employed for starting and stopping the spindles, applying and releasing the brake, and setting the safety device.

There are a number of provisions for speeding up the production of work that will be described in the following; for instance, during the forward and return movement of the tool-slides, the movement is at a considerably increased rate over the feed when the work is being machined. Elliptical spur gears are also used in the spindle indexing train, so that the indexing is accomplished during a comparatively small portion of the machine cycle.

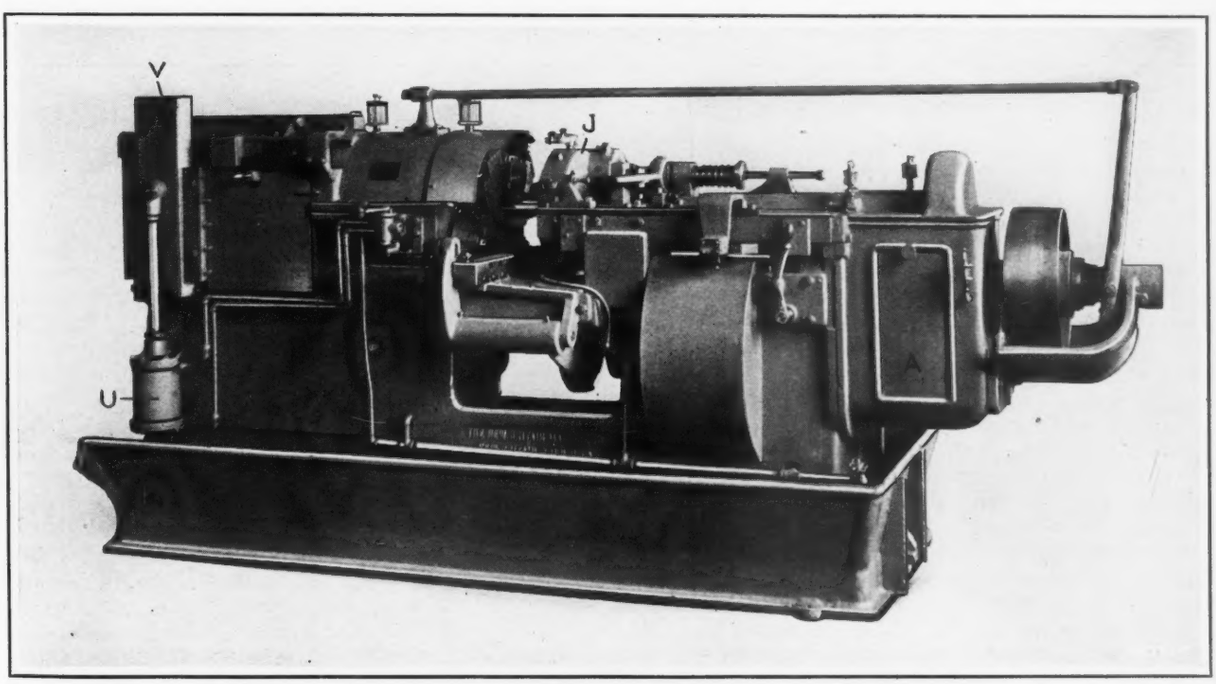


Fig. 1. New Britain "New-Matic" Chucking Machine with Air Control

Driving and Indexing the Spindles

The machine may be either motor- or belt-driven, and is provided with a plain single pulley, or a single pulley equipped with a clutch as illustrated. This clutch is operated by a toggle mechanism actuated by means of an overhead rod, the clutch being adjustable for wear. From the pulley shaft the drive is through change-gears in box *A*, Fig. 1, to shaft *B*, Figs. 3 and 4, which extends forward through the headstock to drive the spindles. The location of the change-gears permits of changing spindle speeds without altering rates of feed and vice versa. At the forward end of shaft *B* is mounted a spur gear which meshes with a gear on each spindle, the spindles being spaced in a circle around the shaft. They are contained in a cylindrical casting which is machined all over and has bearings in the main headstock housing. A large-diameter spur gear is mounted directly on the spindle cylinder to impart the indexing movements.

From the pulley drive shaft, power is taken through a second set of change-gears in box *A* and the gears controlled by clutch handle *H*, Fig. 3, to drive the large cam drum *C*, Fig. 2, by means of a large internal ring gear. By driving through this large internal gear at the circumference of the cam drum and directly under the tool-slide cam block, the torque on the camshaft is greatly diminished. Handle *K*, Fig. 2, provides means of starting or stopping the feed from the rear of the machine. Cam drum *C* drives shaft *D* on which it is mounted and which extends to the forward end of the machine. At a point beneath the headstock, there is an elliptical spur gear on shaft *D* which meshes with a second elliptical gear *E*. On the same shaft as gear *E* is keyed the arm of a Geneva mechanism which intermittently engages the slots of a second part mounted loosely on shaft *D*. The slotted member is geared to the indexing gear on the spindle cylinder, and thus serves to index the cylinder at certain intervals. The use of the elliptical gears permits the indexing to be accomplished during a short portion of the rotation of cam drum *C*.

Spaced equidistantly around the spindle cylinder to suit the number of spindles, are slots which are successively engaged by a locking bolt, ⅞ inch square by 5 inches long. When the moment arrives for indexing the cylinder, the locking bolt is withdrawn from the slot by lever *F*, Fig. 4, which is controlled by a cam on the same shaft as the elliptical gear *E*, Fig. 2. The springs under bar *G*, Fig. 4, push the bolt into place as the succeeding slot is indexed to it, and hold it there until it is time for the next indexing.

Feeding the Tool-slides

The cam strips on drum *C* are employed to feed and return the main tool-slide *J*. This motion is imparted by a shoe between the slide and the cam, which may be attached to the slide in two positions to provide an adjustment of the maximum forward and return positions of the slide in addition to the positions obtained by the location of the cam strips on the drum. Lines and quarter marks on the drum facilitate setting the strips to the stroke suitable for any job. When there is a considerable range of stroke in the work handled, laminated strips are used; otherwise a solid cam is employed. The ways of the longitudinal slide are located centrally in relation to the slide to equalize the thrust of the tools.

Located on shaft *D*, at *L*, Fig. 4, there is a disk with cams mounted on both sides for controlling the movements of the cross-slides. Motion is imparted to the front cross-slide through arm *M*, Fig. 3, and to the rear cross-slide through arm *N*, Fig. 4. The front cross-slide is intended to carry tools for only one work-spindle, and thus is constructed with a horizontal dovetail bearing, whereas the rear cross-slide carries tools for two spindles, and for this reason has a combined horizontal and vertical dovetail bearing. Gibs are provided to take up wear on all slides.

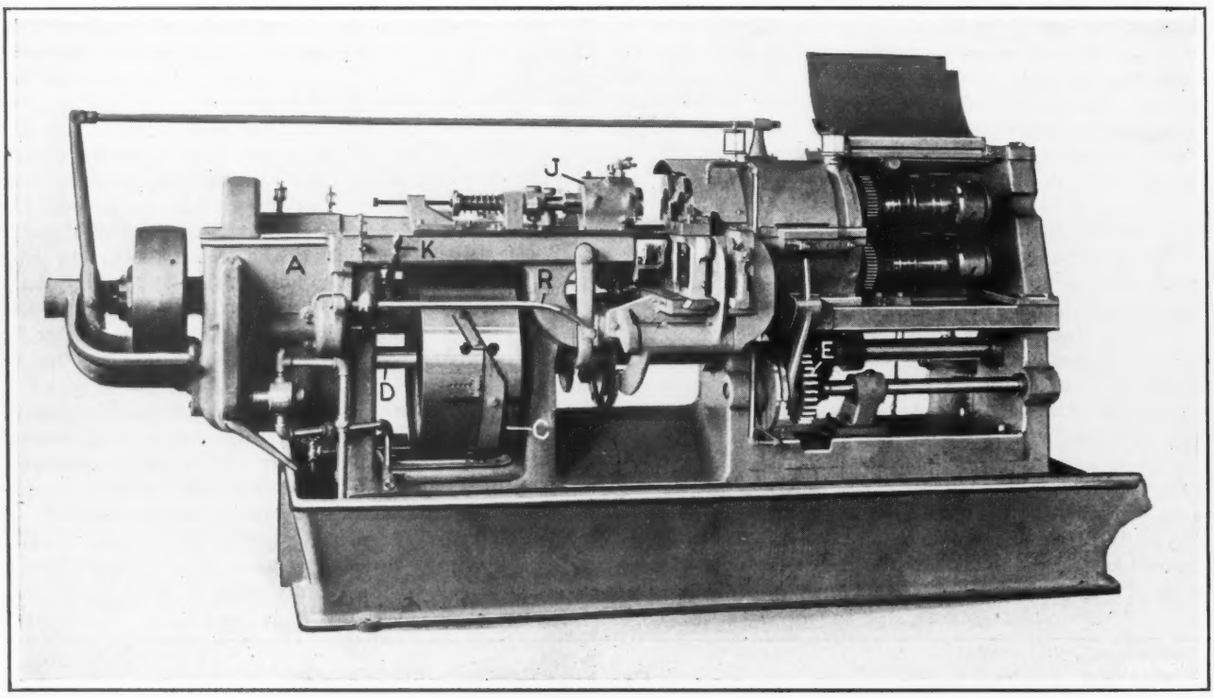


Fig. 2. Rear View of Chucking Machine with Covers removed to show Mechanism

In certain finishing operations, it is desirable to feed the tool the combined length that the roughing tools were fed in the two preceding operations. For instance, it is often necessary to ream a hole in one operation that was bored one-half the length in one step and the remaining length in a second step. To permit such a hole to be reamed to length in one forward movement of the main tool-slide, a special accelerating attachment is provided. From Figs. 3 and 4 it will be seen that this attachment consists essentially of a fulcrum lever *O* which, on the forward movement of the slide, comes in contact with the head of a screw *P* held in a bracket attached to the stationary portion of the machine in which the slide moves. When this occurs, the leverage of part *O* forces the tool forward at twice the rate

of the slide movement. A similar attachment with the fulcrum changed may be furnished to decelerate the feed of the tool, as is sometimes desirable in such operations as taper-reaming.

The drive to cam drum *C* already described, is used during the feeding movement of the slides; however, while they are being advanced to the point of cutting and returned, the slides are moved at a considerably faster rate, as previously explained, so as to reduce the cycle time of the machine. The fast speed is obtained by means of gearing on a shaft revolving at a uniform rate of speed in the rear of gear-box *A*, which is meshed to drive cam drum *C* as the tool-slides begin to recede from the work, the slow drive to the cam being disconnected at the same time. The shifting of the clutch necessary to accomplish this is performed automatically through lever *Q* and rod *R*, Fig. 4, the lever being actuated by a second disk cam on shaft *D*. This arrangement also accelerates the spindle indexing, but it has no influence on the rotation of the spindles. From the shaft through which the fast operation is obtained there is also a constant-speed drive to a pump at the rear of the gear-box, as shown in Fig. 2, which delivers cutting lubricant to the various tools.

For the purpose of observing the relative movements of the various parts, and to facilitate the setting of the different cams, the movements of the slides and the indexing of the spindles can also be accomplished by hand. This is done, after disconnecting the regular drive, by shifting handle *H*, Fig. 3, and then inserting a crank-handle in socket *S*. By revolving the crank-handle, cam drum *C* can be revolved as desired. As a precaution against accident, handle *H* cannot be engaged when the crank-handle is in position.

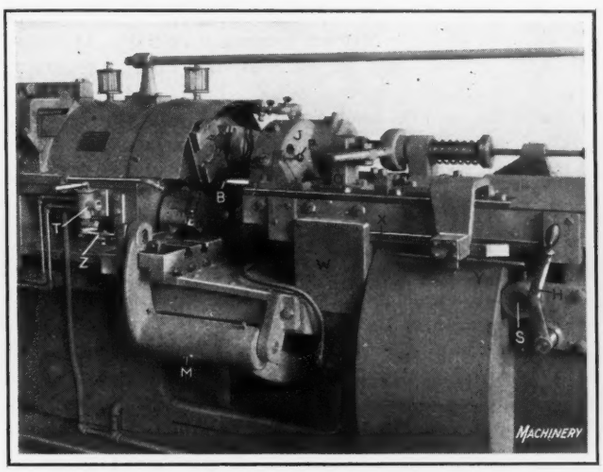


Fig. 3. Close-up View of the Air Valve, Front Cross-slide, Chucks, and Accelerating Attachment

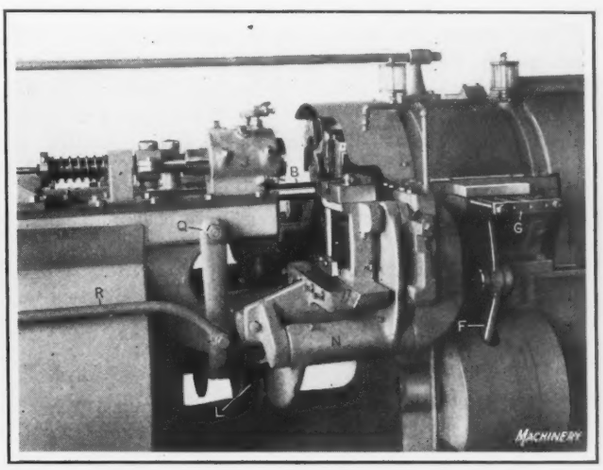


Fig. 4. Rear Cross-slide, Spindle-cylinder Locking Mechanism, and Device for operating the Fast Drive to the Cam Drum

Features of the Air Control

The air valve for controlling the spindle in the loading position, as already outlined, is located at *T*, Fig. 3. In addition to hand operation, the valve may be equipped with a foot-treadle device. As a finished part reaches the loading position, the valve is operated to admit air into the upper portion of the cylinder *U*, Fig. 1, so as to push down the piston and, through the connection, slide *V*. There are two cam paths near the top of this slide, which move longitudinally, and operate successively, the bars that control the spindle driving clutch and brake, and the chuck-jaw operating rod and release. The arrangement of these parts on the spindles may be seen in Fig. 2, where the cover of the headstock is shown raised.

There is a third cam path on slide *V* which operates longitudinally a bar that extends toward the driving end of the machine and that is connected through a gear segment under cover *W*, Fig. 3, to bar *X* on which a dog is mounted. The purpose of this mechanism is to disconnect the drive to the tool-slides and the spindle-indexing mechanism in case the operator has not chucked a new piece of work by the time that the main tool-slide has completed its return movement. Attached to this tool-slide is a bracket to which is fastened rod *Y*. When the spindle has been reloaded and the air valve is operated to chuck the work, release the brake, and start the spindle rotating, rod *X* and its dog is moved forward, so that the dog pushes the part containing rod *Y* sidewise, thus permitting the rod to clear handle *H*. However, if the air valve is not operated, the dog on bar *X* will be too far to the rear to move rod *Y* sidewise, and so the rod will strike handle *H* and stop the machine with the exception of the spindle rotation. Obviously, when the air valve handle is operated to chuck a new piece, release the brake, and start the spindle, air is admitted into the lower part of the cylinder to push the piston and slide *V* up. When the work is released in unchucking, a slight knock is given to the chuck-operating rod to loosen the work.

During the time that the tool-slides are being returned and the spindle-carrying cylinder indexed, it is impossible to operate the air control to open the chucks. This is arranged by means of lever *Z*, Fig. 3, which comes in contact with the front tool-slide when withdrawn and brings the air control handle to a neutral position, preventing air from being applied to release the chuck. This feature is important in connection with the handling of two machines by one operator, as the operator might turn to a machine just ready to index and attempt to open the chuck before the indexing has been completed and the spindle locked.

SUNDSTRAND DOUBLE-SPINDLE MILLING MACHINE

A milling machine equipped with two spindles and a turret for carrying the work past the cutters has been developed by the Rockford Milling Machine Co., Rockford, Ill. The production of this machine is said to be limited only by the ability of the operator to reload. It is not a single-purpose machine, being especially versatile because of various combinations of movements secured by the simple adjustment of dogs on two feed-drums. It can be set for continuous milling with the turret revolving constantly and the spindle head stationary, or with the turret fed and the spindle head stationary, the turret being indexed to the next position and the cycle repeated. For gash milling, the turret can index, remain stationary while the spindle head automatically feeds in for the operation and backs out after it has been accomplished, and then index again to the next milling position. The turret can also be indexed without feeding, and there may be either four or eight indexings per revolution of the drum.

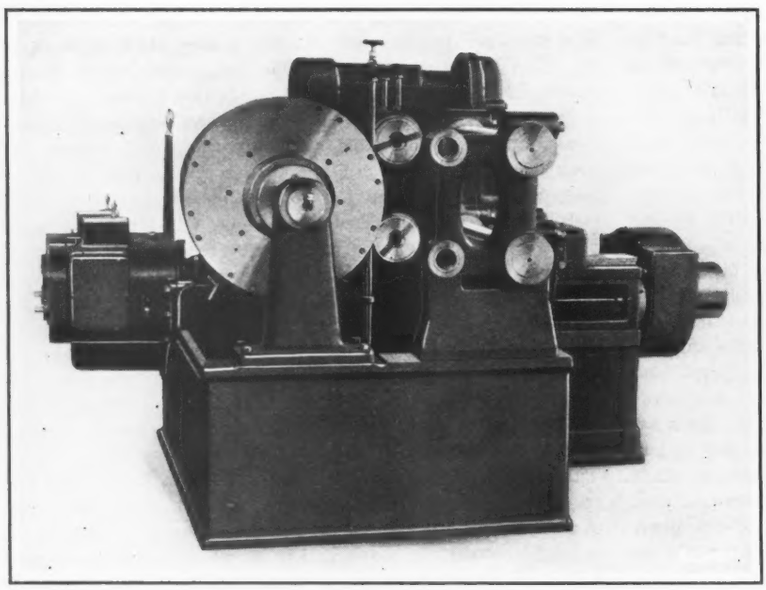


Fig. 1. Sundstrand Double-spindle Continuous Milling Machine

When two cuts are to be taken on a piece of work, the upper spindle may carry roughing cutters, and the lower, finishing cutters. However, when mass production is required, both spindles can be used for roughing. In this case the turret can be made to index two stations at a time by making a simple adjustment of the dogs on the feed-drum. One of the important points of any production machine is the factor of loading and unloading. With a view to minimizing the effort required of the operator in reloading, the turret and all control levers have been conveniently placed. Furthermore, the cutters face the turret, and the spray of the coolant is downward over the cutters and the work. This arrangement washes chips off the fixture and leaves clean surfaces for the next piece of work, eliminating the loss of time incident to cleaning fixtures.

The spindle head is operated forward and backward on a dovetail way on the base by a screw located at the center of the way. The upper spindle is driven through a large worm-gear and a worm mounted in high-duty roller bearings, change-gears providing for different speeds. Inasmuch as the lower spindle is used mostly for finishing cuts, change-gears which give a wide range of speed are arranged on the rear side of the head. The upper and lower spindles can be arranged to run at the same speeds when taking roughing cuts in mass production. The spindle-driving mechanism runs in a bath of oil, and the shafts are hardened and ground and equipped with roller bearings. The main drive consists of a long horizontal gear connected to a driving gear in the spindle head, a design which eliminates sliding a gear on the driving shaft. To add to the rigidity of the two spindles, an arbor support and two over-arms with a heavy outboard support are furnished. As the cut is upward, the natural tendency for the cutters is to bear down, and so with this support all chatter and vibration is said to be eliminated.

The heavy shaft on which the turret is mounted is held stationary and is supported at both ends, first in a housing that is adjustable on the bed, and second in an outboard bearing bolted to the bed. The housing is adjustable a distance of 4 inches parallel with the spindles. By revolving the drum on the shaft, heavy work can be put on the machine without there being any tendency to chatter. Another feature of the stationary shaft is convenience in mounting fixtures or replacing the drum. The turret may be round, square, hexagon or octagon, depending on the work, each turret being especially designed for the job, as the size of the surface to be machined governs the diameters of the cutters and the size of the turret.

The control of the various feeds on this machine is automatic, and as already mentioned, several combinations of feeds can be obtained through the adjustment of two graduated revolving drums. The drum on the left-hand side of the machine controls the turret, and that on the right-hand side, the travel of the spindle head. The machine may be furnished with either a belt or motor drive. With a belt drive the power is delivered to a pulley at the rear, and a starting and stopping lever is conveniently located at the left of the operator for controlling this pulley. When equipped with a motor, a silent-chain drive can be employed. The coolant pump, at the left-hand side of the base, is driven from the main drive shaft.

Some of the principal specifications of this machine are as follows: Range of spindle speeds, 17 to 156 revolutions per minute; distance between centers of spindles, 12 inches; distance between face of spindles and arbor support, 20 inches; maximum travel of spindle head, 10 inches; range of feeds for spindle head and turret, 1.4 to 9.7 inches per minute; maximum swing of turret, 38 inches; and weight of machine, about 8360 pounds.

BICKFORD THREAD MILLING MACHINE

A relieved thread can be milled on pipe taps during a single revolution of the tap by the use of a redesigned special thread milling machine recently brought out by the O. S. Bickford & Son Co., 243 Silver St., Greenfield, Mass. Two center brackets on this machine slide on a heavy steel bar which is attached to both a slide and a roll. The tail-center bracket supports the small or point end of the tap, while the shank end is carried on a screw center in the spindle of the head-center bracket. There is a shaft mounted parallel to the main bar which carries a relief cam, and a steel pin on the tail-center rides on this cam. The cam-shaft also carries a long gear which drives the work-spindle in the head-center bracket through an idler. It will thus

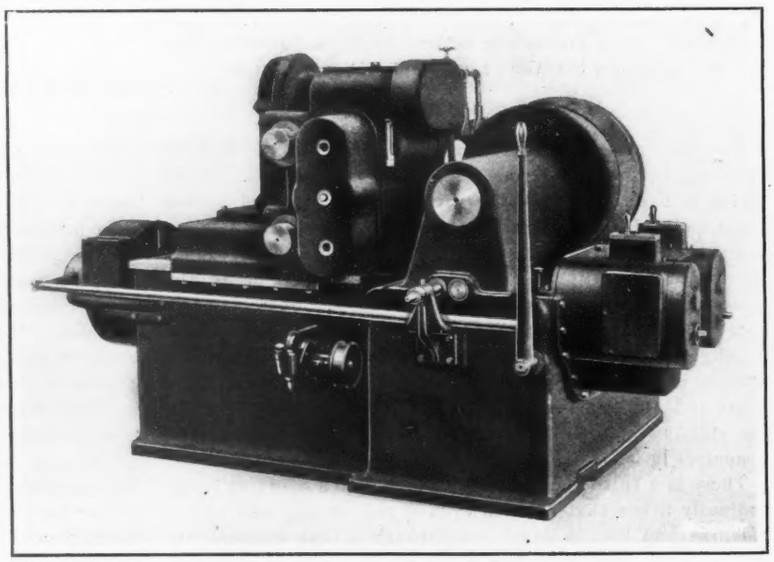
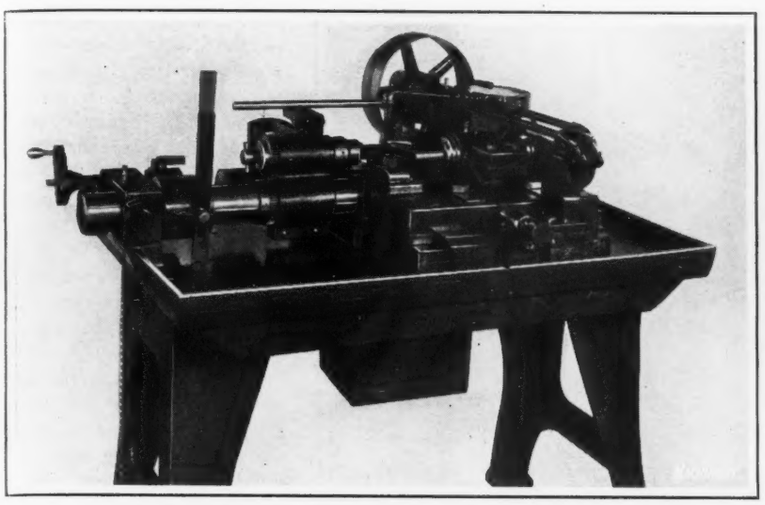


Fig. 2. Rear View of the Double-spindle Milling Machine



Bickford Thread Milling Machine of Improved Design

be understood that the head-center spindle revolves the tap, and as the cam and tap revolve together, the rise on the cam produces the relief on the tap. One end of the camshaft carries a quill, or short lead-screw, which is engaged by half-nuts held in brackets on the main bar, and thus as the lead-screw revolves, the tap is fed forward to obtain the proper lead.

The driving pulley is connected to the pulley shaft by operating the lever shown. On this shaft are two worms, one of which has a single thread and delivers power through change-gears to the camshaft which, as previously mentioned, drives the work. The other worm has a quadruple thread and drives a gear on the spindle carrying the hob cutter that threads the tap. With a carbon-steel hob, it is said that the machine will thread a ¼-inch pipe tap in 1½ minutes, or a 4-inch pipe tap in 8 minutes.

The machine is also arranged for cutting the teeth on its own hobs, in which case the spiral-fluted hob blank is held on a collar arbor between the same centers that hold the taps. A master cutter for producing a single tooth is mounted on the cutter-spindle, and the pin on the tail-center bracket is again set to ride the spiral cam. The lead-screw is locked to the frame of the machine instead of to the camshaft, and the result is an annular thread on the hob instead of a thread having a lead. After one tooth has been milled, the lead-screw is turned ahead one revolution by means of a hand-crank, and the next tooth is milled.

Another application of the machine is for threading the shanks of pipe wrench jaws, in which case the end threaded has two flat surfaces between the two circular edges on which the thread is milled. For this work, a special device has been added to the machine, which turns the work slowly while the hob travels across one circular edge of the shank, and then turns it quickly when a flat surface reaches the hob until the hob begins cutting on the second circular edge. By this method, fully half of the feeding time is saved, and the production correspondingly increased. The range of the machine, when used for this work, is for jaws from 6 to 36 inches. The weight of the machine has been increased throughout more than 25 per cent, so that it now weighs about 1900 pounds.

BULLARD SIX-SPINDLE "CONTIN-U-MATIC"

A rapid-production machine for turning, facing, and grooving work simultaneously has been developed by the Bullard Machine Tool Co., Bridgeport, Conn. This is a six-spindle vertical machine of somewhat similar construction to the four-spindle machine brought out by the company some time ago. On this machine a tool-head moves with each work-spindle in a continuous cycle around the machine. During the time that each unit moves through a certain distance at the front of the machine, the work-spindle is stationary to permit reloading the chuck, but when the end of the idle movement has been reached, a clutch is engaged automatically to revolve the spindle on its own center. Simultaneously with the starting of the spindle rotation, three slides on the tool-head are fed toward the work, the feeds being so timed that the work is finished just before it reaches the loading point. Because of the principle on which the machine operates, it has been named the "Contin-U-Matic."

In the illustrations the machine is shown arranged for producing cast-iron automobile pistons, the operation consisting of turning, facing, and grooving. For this work it is intended that the machine be used in pairs —one for rough-machining the piston, and the other for finishing it. The average production from each machine is one piston every 18 seconds, the output being limited only by the ability of the operator to load the chucks.

The tooling provided for each spindle is shown in Fig. 2, which illustrates the machining operation shortly before it is completed. It will be seen that there is a tool on slide *A* for turning the periphery, a tool on slide *B* for facing the closed end, and three tools on slide *C* for producing the piston-ring grooves. The machine has a capacity for work up to about 10 inches in diameter and 14 inches in length. Instead of having all spindles and tool-heads set up for one piece of work, the machine can be arranged for handling two or more pieces of work, by alternating the set-ups.

The drive is from an overhead 15-horsepower motor, supported on a central stationary column, and is delivered

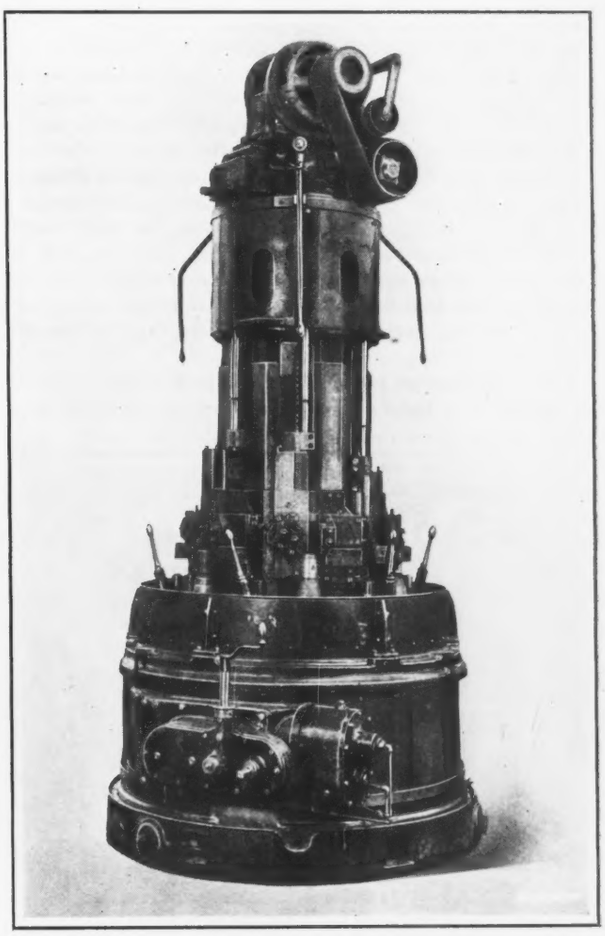


Fig. 1. Bullard Six-spindle "Contin-U-Matic"

through a belt to a speed-change box also located at the top of the column. From this gear-box the drive is through a clutch to a vertical shaft at the center of the column. The clutch may be operated by one of the three long handles seen in Fig. 1, and hence the machine can be started or stopped from any position. From the lower end of the central shaft the drive is through spur gears to a short vertical shaft, at the top of which there is a spur pinion which drives the inside teeth of a large combined internal and external spur gear. The external teeth drive six intermediate gears, on the shafts of which is mounted a gear that drives a chuck spindle. The intermediate gear shafts rotate constantly, but the spindles are not rotated while in the loading position because of a clutch on the intermediate gear shaft being disconnected. The disengagement of this clutch and its subsequent re-engagement are accomplished automatically by means of a cam on the base. Therefore the pinions that actually drive the chuck spindles are always in mesh, so that there is no sliding of gears in starting and stopping the spindles.

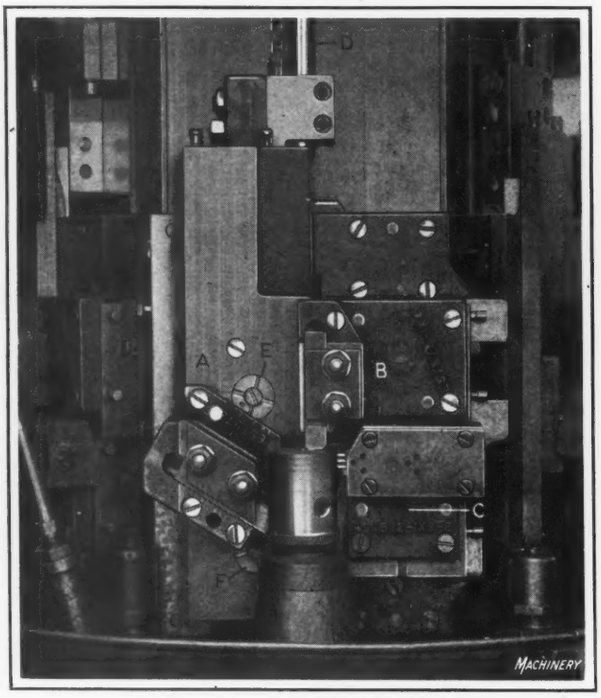


Fig. 2. One Set of Tooling engaged in roughing a Piston

From the central driving shaft power is also delivered through bevel gearing and a horizontal shaft to the gear-box seen on the base at the front of the machine in Fig. 1. The gears in this box control the speed of rotation of a worm that drives the table and tool-head housing around the machine. This worm meshes with a large worm-gear mounted on the table, which is supported on six radial ball bearings. By shifting a clutch in the drive to the table, the latter and the tool-head housing may also be driven by power in the reverse direction. From this description it will be apparent that the spindle speeds are controlled by the overhead gear-box and the machine cycle by both the overhead gear-box and the one at the front of the base. The spindle speeds range from 50 to 150 revolutions per minute, and the machine cycle can be made to suit the time required for loading.

There is a special power chuck for each spindle, operated by means of a handle located adjacent to the spindle, as shown in Fig. 1. In the case of the piston, the work is placed on the chuck, and a pin is inserted through the piston-pin hole and through the hole in a tongue at the center of the chuck. The handle is then operated to seat the piston firmly on the skirt end. Power for the actual gripping of the work is derived through gearing, and so the energy of the operator is conserved.

Each tool-head is connected, by means of a rod *D*, Fig. 2, carrying a roller at the upper end, to a stationary cam which extends around the machine at the top. It is by this means that the feeds of the tool-slides are controlled. After a work-spindle and tool-head together leave the loading position, rod *D* forces the vertical slide *A* down, for the turning cut. On the inside of this slide two cams are mounted at *E* and *F*, the cam at *E* engaging an angular slot on slide *B* to feed it horizontally toward the work, and the cam at *F* engaging a similar slot on slide *C*. Slide *C* moves a shorter distance than slide *B*, because of the smaller amount of stock removed by the tools on slide *C*, and hence the slot on this slide is less inclined than that on slide *B*.

The feeding of rod *D* is gradual until the operation is completed, when there is a sudden rise in the cam to carry the tools quickly from the work. The cam is made special to suit the job, and so are the tool-heads and chucks. The tool-heads are counterweighted to reduce the load on the cam, and there is an accurate adjustment for each cutter. All gears and bearings throughout the machine are copiously oiled, the lubricant being pumped to a tank at the top of the machine and flowing by gravity to the various points.

GREENLEE DRILLING AND TAPPING MACHINES

Four fixed-center multiple-spindle drilling and tapping machines have recently been built by Greenlee Bros. & Co., Rockford, Ill. Fig. 1 shows a one-way machine equipped with a twenty-seven-spindle head for drilling holes in a

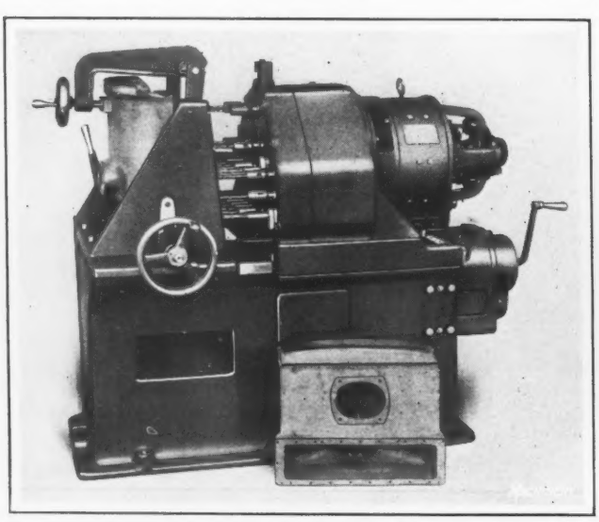


Fig. 1. Greenlee One-way Machine arranged for drilling Twenty-seven Holes in a Tractor Radiator Tank

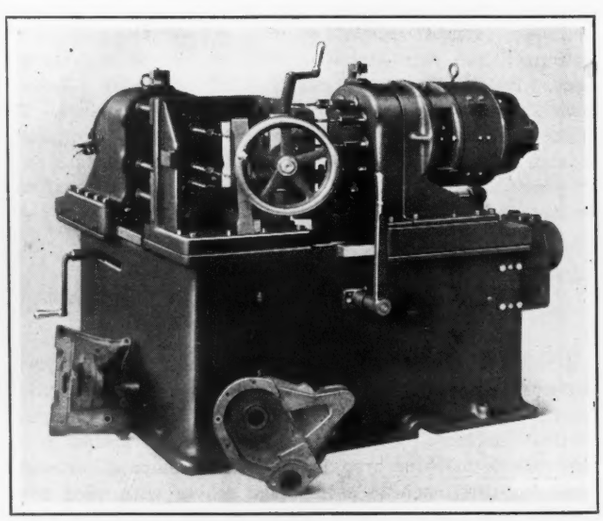


Fig. 2. Machine with Two Heads arranged at Right Angles to Each Other

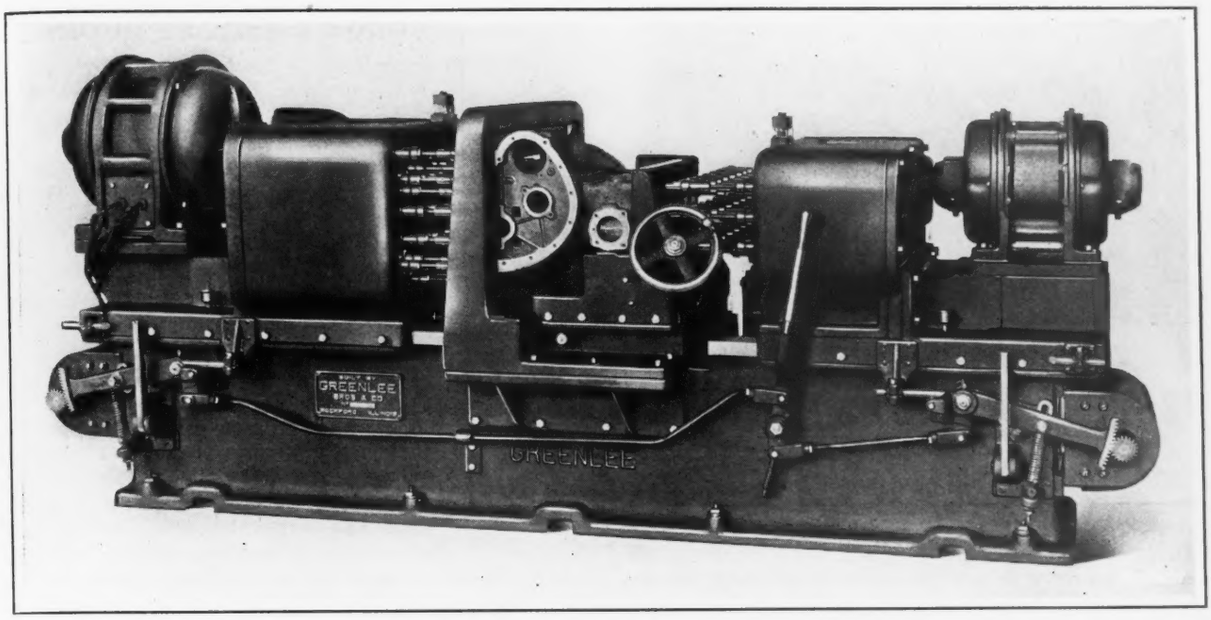


Fig. 3. Two-way Machine for tapping Holes in an Automobile Cylinder Block

tractor radiator tank; Fig. 2, a machine with two heads arranged on ways at right angles to each other for drilling holes in two faces of an odd-shaped casting; Fig. 3, a two-way horizontal machine arranged for tapping holes in the top and bottom of an automobile cylinder block; and Fig. 4, a three-way combination horizontal and vertical machine arranged for drilling the bottom and two ends of a cylinder block. All are high-production, single-purpose machines designed especially for the job on which they are used, but incorporating such standard units as frames, head slides, feed-boxes and stop mechanisms.

The heads in each case are built as units removable from the slides. They are individually motor-driven, the motor being mounted in a horizontal position through the use of an adapter in place of the front-end bell, or else directly on supports provided on the slide. When the adapter is used, a sleeve gear mounted on ball bearings serves as the front bearing of the armature. The spindles, shafts, and gears throughout the heads are mounted on anti-friction bearings of either the ball or roller type. The drill spindles are arranged with taper-shank collets and are provided with an endwise adjustment of 1 inch to suit varying lengths of drills. A geared oil-pump is mounted on each head, and is driven from an intermediate gear in the head. The oil is pumped from a reservoir and settling tank at the bottom of the head, through a glass oil-tube at the top and then into a small reservoir, from which it is piped to the various trains of gearing for cascade distribution.

A screw feed is used on the one-way and on the two-way right-angle machines, a feed-box being mounted as a unit between the ways of the frame at one end of the machine. Power is transmitted to the feed-box from one head through gearing and a splined shaft. The drilling feed is obtained through worm-gearing engaged by means of a jaw clutch. When the drills have reached the desired depth, a stop previously set on the slide releases a load-and-fire mechanism which disengages the forward-feed clutch and engages a reversing clutch to return the head to its starting position. This is accomplished through spur gearing, at the rate of 100 inches per minute. The stop at the rear position throws both clutches into the neutral position, and there is also a safety jaw clutch in the feed-drive unit.

On the machine shown in Fig. 1 the head is arranged for drilling 13/32-, 5/16-, and 9/32-inch holes, and it is driven by a five-horsepower motor. The closest spindle center is 7/8 inch, and the maximum, 4 inches. The work is located sidewise in the fixture by an equalizer operated through a right- and left-hand screw and the handwheel shown at the side. Finished surfaces are clamped against hardened steel locaters by the clamp screw at the top and two hook clamps which enter a rectangular opening near the bottom of the casting. The pressure of the three clamps is equalized by tightening the handwheel at the top.

The right-hand head of the machine illustrated in Fig. 2 is arranged for drilling one 13/32-inch, four 15/32-inch and two 17/32-inch holes, and the left-hand head, for drilling four 13/32-inch, three 9/16-inch, and one 23/32-inch holes. Both heads are driven by a motor of the same horsepower capacity as the head of the one-way machine. The feed-box is at the right-hand end of the frame, and receives its power from the head at this end, the feed-screw for the left-hand end being driven through bevel gears by the screw for the right-hand head. The feed is controlled by the lever on the right-hand side of the machine. For adjusting the left-hand head in relation to the right-hand head, so that both will complete their drilling cycle at the same time, there is provided on the left-hand feed-screw, a worm-gear which acts as a feed-nut. The gear is adjusted

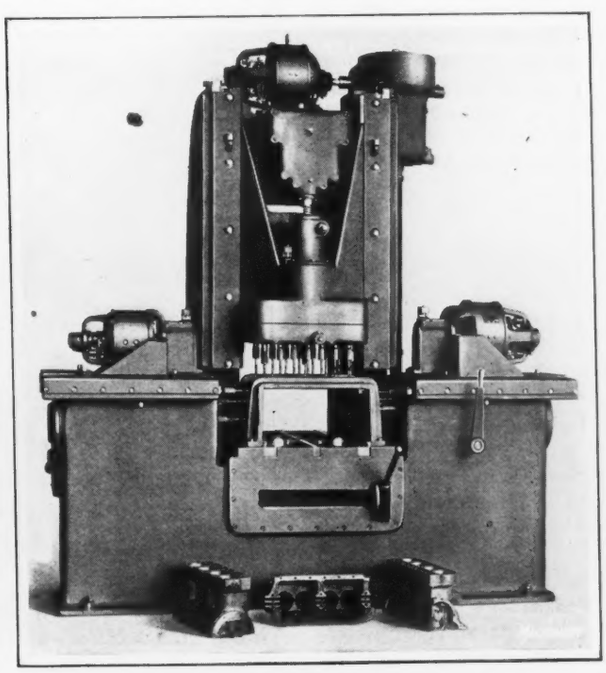


Fig. 4. Three-way Combined Horizontal and Vertical Machine

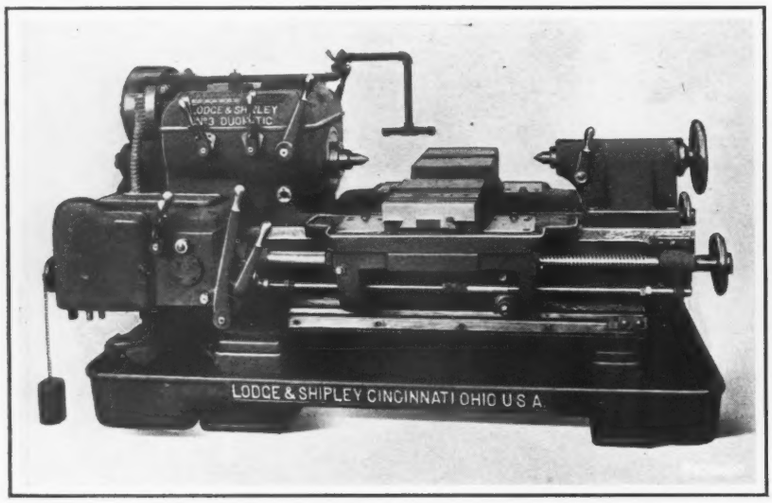


Fig. 1. Lodge & Shipley Automatic Lathe known as the "Duomatic"

LODGE & SHIPLEY DUOMATIC

An automatic lathe with multiple tooling for performing turning and facing operations has been placed on the market under the trade name of "Duomatic" by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio. This machine is adapted for the quantity production of lathe work, whether held between centers, on an arbor, or in suitable fixtures. The cycle of operation is completely automatic, including the control of diameters and lengths on the work. The proper dimensions are obtained by means of positive metal-to-metal stops which insure a high degree of accuracy.

As its name implies, the "Duomatic" is dual in character, having two carriages equipped with tool-slides. Each of these units has an independent power quick forward and return traverse, as well as a power feed to both the carriage and tool-slide. As a result, both carriages can be used simultaneously in turning operations, both tool-slides can be used in facing operations, or, as is usually the case, one carriage with its tool-slide, can be utilized in a turning operation, while the other carriage and tool-slide is being used in a facing and filleting operation. The dual construction, combined with the simple method of adjusting for the various functions, makes the machine adaptable for a variety of work without the use of special attachments or parts. The rotation of the feed-screw gives the cross movement to the tool-slide and the longitudinal movement to the carriage. An adjustable threaded micrometer sleeve arrests the movement of the cross-slide to fix the diameters of the work, and the adjustment of a pair of nuts on a threaded stop-bar limits the movement of the carriage in either direction.

along the feed-screw by a worm, the shaft of which extends through the long slot in the base.

The right-hand head of the machine shown in Fig. 3 is arranged for tapping twenty-two 7/16-inch, one 5/8-inch, two 3/8-inch and one 5/16-inch holes in the top of the cylinder block. The left-hand head is arranged for tapping eight 1/4-inch, twenty-one 5/16-inch, thirteen 3/8-inch, four 7/16-inch, and twelve 1/2-inch holes and one 1/4-inch pipe-tap hole. The right-hand head is driven by a 10-horsepower motor, and the left-hand head by a 25-horsepower motor. The gearing in the heads is such that the number of revolutions per minute of the spindles is in direct proportion to the pitch of their respective taps, and therefore all taps advance the same. The tap-holders have a 1/2-inch endwise adjustment to suit varying lengths. In backing out the taps and returning the heads to the starting positions, the motor is reversed through drum-type controllers. To advance the heads toward the work, the long lever at the front of the machine is moved to the left. When the heads reach the forward position, adjustable stops at the ends of the slides cause the reverse to function. Then, when the heads have returned to the starting position, stops at the middle of the slides place the mechanism in neutral.

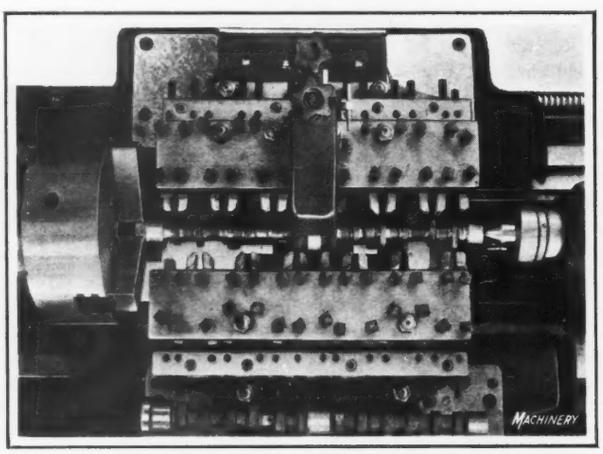


Fig. 2. Tooling Equipment used in machining an Automobile Camshaft

The top head of the machine shown in Fig. 4 is arranged for drilling fourteen 25/64-inch, two 5/16-inch and one 7/16-inch holes, and is driven by a 7½-horsepower motor; the right-hand head is arranged for drilling one 13/32-inch and four 21/64-inch holes, and is equipped with a three-horsepower motor; and the left-hand head is arranged for drilling one 7/16-inch, two 21/64-inch and one 13/32-inch holes, and is provided with a two-horsepower motor. On this machine a cam feed is used, the cam being carried in such a position that its roller and slide are in the center line of the spindle thrust. A three-horsepower motor on top of the machine is used for driving the feed mechanism, being engaged by a jaw clutch operated by the lever adjacent to the right-hand head. A dog attached to the cam for this head automatically disengages the clutch after a drilling cycle has been completed. To adjust the heads for depth of drilling and in relation to each other, there is provided a self-locking worm and gear on an adjusting screw which attaches the heads to their cam roller slides.

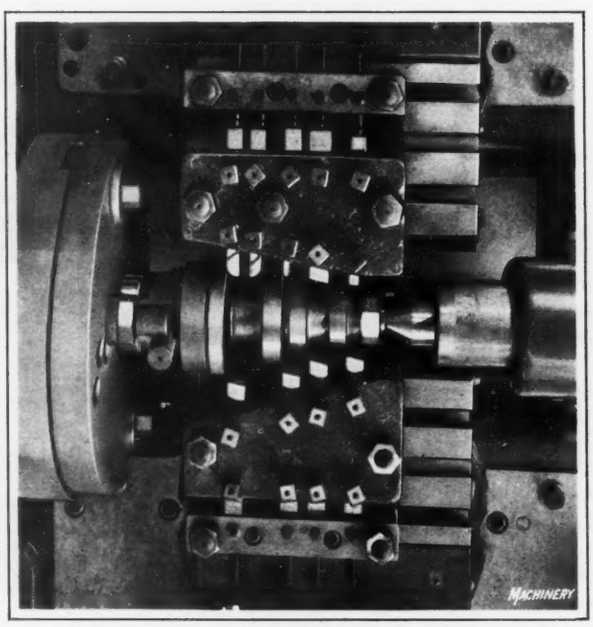


Fig. 3. Arrangement of the Tooling for finishing a Cluster Gear

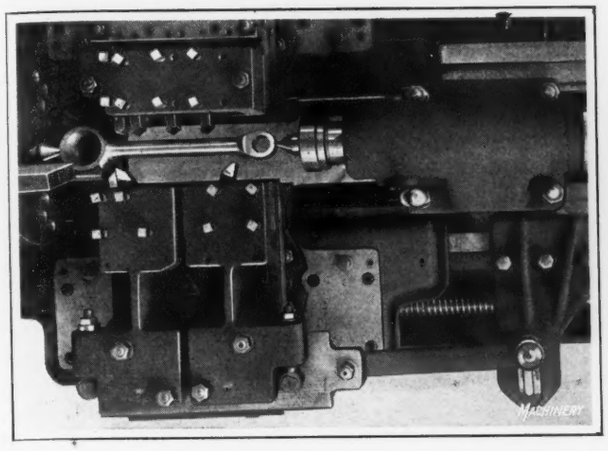


Fig. 4. Straight- and Form-turning of a Tubular Connecting-rod on the "Duomatic"

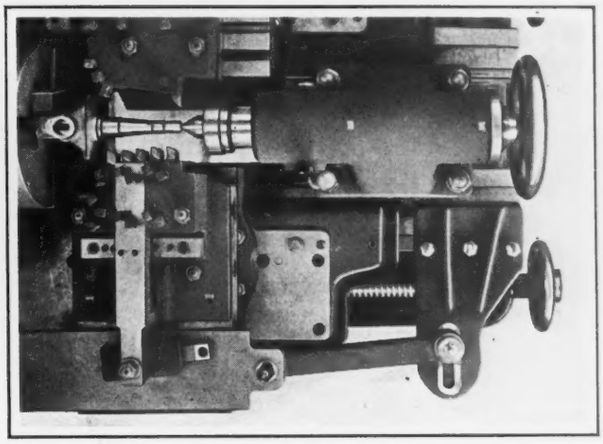


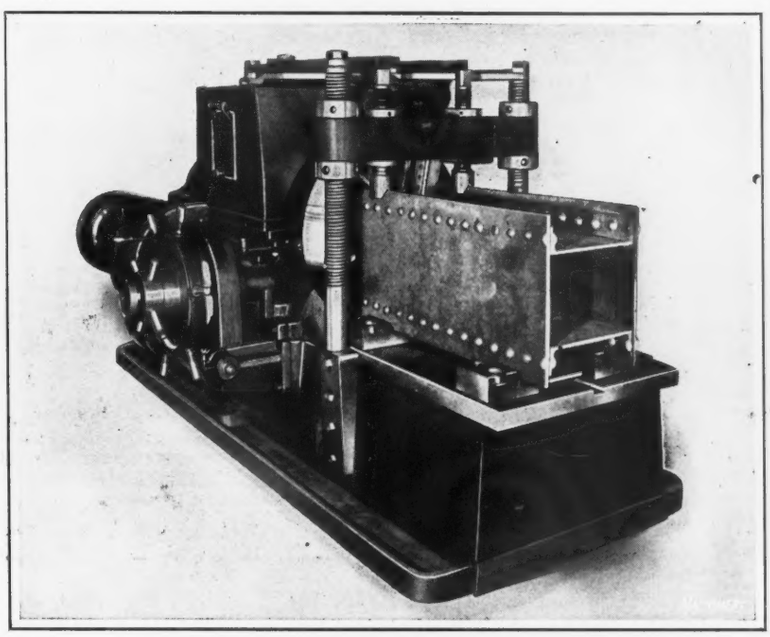
Fig. 5. Straight- and Taper-turning of a Steering Spindle for a Four-wheel Brake Automobile

The single pulley drive with its multiple-plate clutch is said to transmit unusual power to the main spindle of the headstock. The shafts carrying the gears of this drive are mounted in ball bearings. The bed, carriages, and tool-slides are designed to absorb cutting strains and obviate vibration and chatter, thus increasing the life of the cutting tools. Hardened alloy steel parts have been used liberally to obtain a substantial construction, and large bearing surfaces on the carriages and tool-slides insure long life and relative freedom from adjustment. The headstock and the clutch mechanism, as well as the feed and power-traverse mechanism are enclosed and automatically lubricated.

Several typical operations performed on this machine are shown in the accompanying illustrations. Fig. 2 shows the tooling equipment used in machining automobile camshafts; Fig. 3 shows the finishing of a transmission cluster gear; Fig. 4, the straight- and form-turning of a tubular connecting-rod, both carriages being used for turning; and Fig. 5, the turning of a steering spindle for a four-wheel brake automobile. In the last operation straight- and taper-turning are being performed at the same time.

NEWTON HEAVY-DUTY COLUMN-FACING MACHINE

A machine for facing the ends of columns, girders, and beams has been placed on the market by the Newton Machine Tool Works, 23rd and Vine Sts., Philadelphia, Pa., of the Consolidated Machine Tool Corporation of America. This machine is a modification of a rail ending machine built in the past by the same company. It has a capacity for I-beams up to 27 inches and H-columns up to 22 inches. The cutter-head is a steel casting, 31½ inches in diameter over the tools, which are fitted in radial slots and held by wedge-shaped clamps. The spindle is made from a carbon-steel hammered forging, and is hardened and ground. It is fitted in scraped bronze-bushed bearings which are capped to provide compensation for wear. There is a hand adjustment for the spindle by means of the large pilot wheel.



Newton Heavy-duty Machine for facing Columns, I-beams, etc.

The spindle has a feed traverse of 2 inches, the feeding movement being obtained through a stationary screw and a revolving nut. A power rapid return to the spindle is provided through a friction clutch. Both the feed and the power return are automatically disengaged at either end of the traverse so as to prevent damage to the machine, and they are controlled by the same lever. The power feed friction clutch is released by a fly nut.

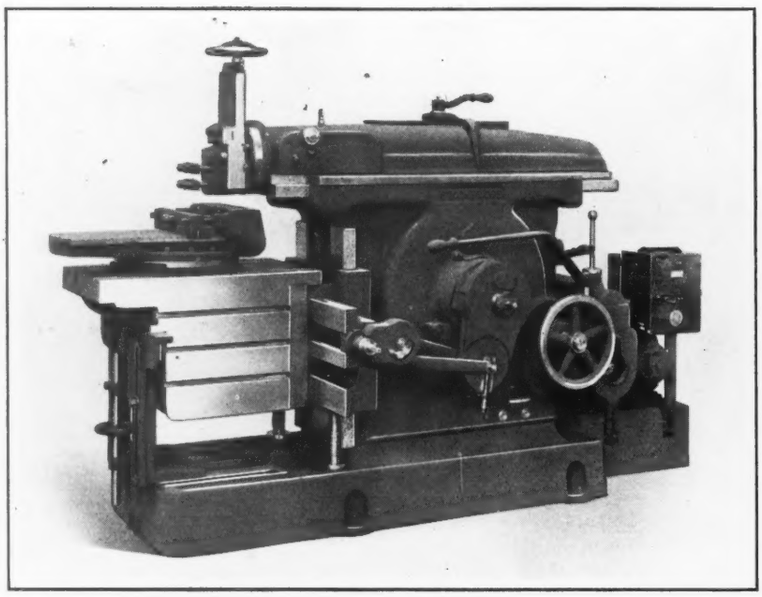
The machine can be arranged for either a belt drive or a belt-connected motor drive. In the latter case, the motor is mounted on a box-type shelf casting bolted to the top of the machine to form a cover over the driving worm. This casting is fitted with adjustable motor rails. A 20-horsepower constant-speed motor running at 1200 revolutions per minute is recommended, although when variations in the hardness of materials to be machined necessitates different speeds, a variable-speed motor running at from 600 to 1200 revolutions per minute is used. Pumping equipment is furnished for supplying lubricant to the cutters.

STOCKBRIDGE HEAVY-DUTY SHAPER

A 32-inch heavy-duty crank shaper embodying several new features has been brought out by the Stockbridge Machine Co., Worcester, Mass. In this machine the bull gear is carried between two bearings, with the usual hub bearing on one side and an outer support or ring bearing on the opposite side. This outer bearing is on the inside of the column close to the rocker arm, and consists of a ring fitted into the column. The full-diameter outer journal of the bull gear revolves in this ring bearing and is lubricated by means of rollers running in an oil well. The bull gear and pinion have helical teeth. This construction is said to give additional rigidity of special

value in taking heavy roughing cuts and wide finishing cuts.

Eight speeds are provided for the ram, and this member can be positioned and adjusted to any length of stroke without stopping the machine. The head has a graduated swivel for setting to angular positions and is provided with a clapper-box equipped with a planer-type solid binding clamp. A rapid hand traverse is provided for the head, and a power down feed can be furnished. The cross-rail is of the three-track type and is elevated by two screws. The saddle is held in position by two square gibs, and a third gib at the bottom prevents lifting. There are two working sides on the table, and this member can be easily removed for clamping work direct to the saddle. The cross-feed operates only on the return of the ram and is automatic. It can be varied or reversed while the machine is in motion, the direction of the feed being controlled by throwing a handle to the right or left. The speed-box is of the selective sliding-gear type and gives four speed changes.



Stockbridge Heavy-duty Shaper of Improved Construction

When equipped with a motor drive, a constant-speed motor is mounted on an extension of the base and connected to the gear-box through gearing. A friction clutch and brake are provided for starting and stopping the machine, respectively. Any alternating- or direct-current motor having a speed of from 1700 to 1800 revolutions per minute is recommended. The shaper may be equipped with special attachments for railroad work, including an extended circular feeding head for locomotive driving-boxes, a shoe-and-wedge chuck, and a boom crane.

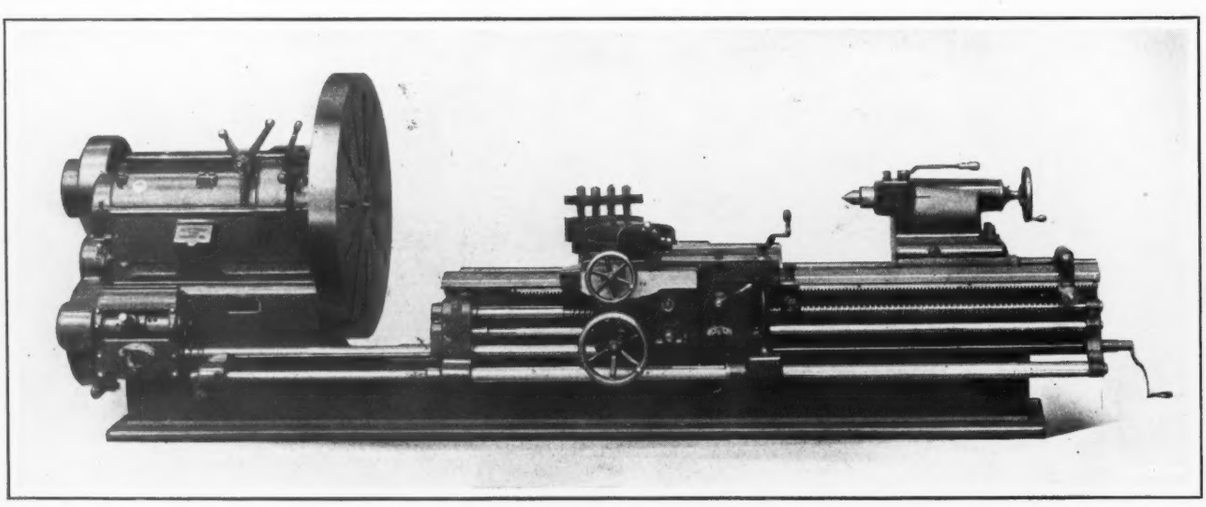
LEBLOND SLIDING-BED GAP LATHE

A 25- to 50-inch heavy-duty sliding-bed gap lathe has been brought out by the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. From the illustration it will be seen that both sections of the bed are large in vertical depth and width. The rear carriage bearing is flat, and the front shear is of the "improved compensating vee" design which has been described in the past in connection with other lathes built by this company. The top bed is movable on the lower bed by means of a coarse-pitch screw, which is always kept in alignment by a yee on the lower bed and is held in position by two heavy clamps. The design allows the upper bed to be adjusted to any width of gap to accommodate large-diameter work and also to increase the length that can be received between centers. The apron is a regular box casting in which all bearings for shafts and screws are cast integral. Both feeds are operated by a single positive clutch, and the cross and length feeds and screw cutting mechanisms are interlocked.

The headstock and other parts are similar to the same units of the heavy-duty 25-inch lathe described in January, 1923, MACHINERY. On the gap-bed lathe, the actual swing over the shears is 27½ inches, and over the gap, 52½ inches; the distance between centers with a 14-foot bed closed, 7 feet 9½ inches, and extended, 12 feet 9½ inches; and the domestic shipping weight with a 14-foot bed, about 14,000 pounds.

CINCINNATI TOOL-ROOM SHAPER

A tool-room shaper has just been brought out by the Cincinnati Shaper Co., Elam St. and Garrard Ave., Cincinnati, Ohio. This machine is of the same design as the "Climax" shaper built by the same company, which was described in December MACHINERY, except that it is provided with a universal swiveling table and may be equipped with either a single-pulley or motor drive. As the regular internal transmission of the machine provides eight speed changes, a constant-speed motor is used in all motor drives, the motor being bolted to the base and column at the rear, and belt-



LeBlond Heavy-duty Sliding-bed Gap Lathe

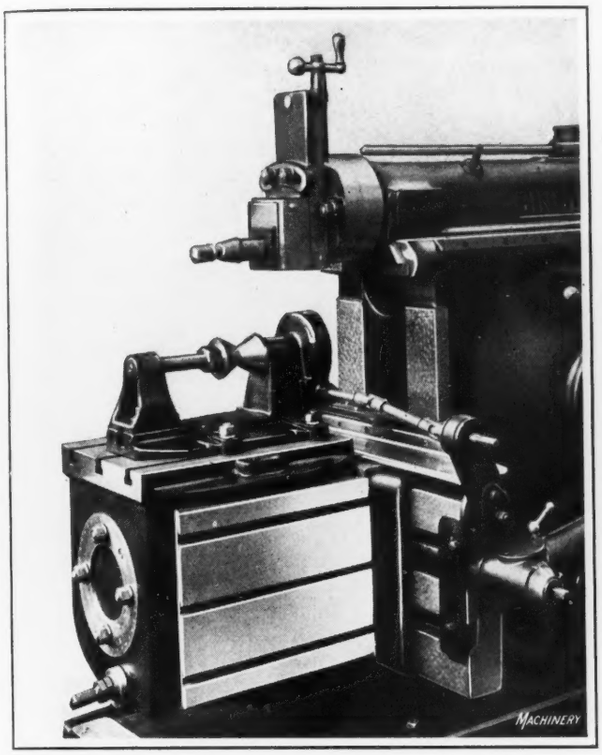


Fig. 1. Cincinnati Tool-room Shaper equipped with Swivel Table and Cone Arbor

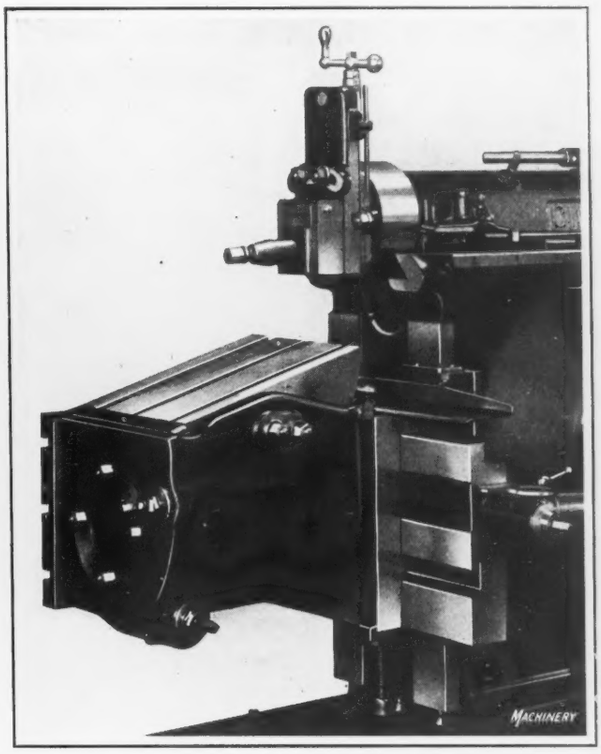


Fig. 2. Illustration showing how the Rocking Top of the Table may be used

connected to the main driving pulley. The recommended speed for the motor is 1800 revolutions per minute. A ball-bearing counterweighted idler pulley is used on the slack side of the belt to take up automatically any stretch and increase the arc of contact on the pulley as the load increases.

The table is arranged to swivel about a heavy trunnion which is cast solid with the apron and extends the full length of the table, as shown in the illustrations. A worm and worm-wheel mechanism is operated by means of a crank-wrench to revolve the table to any angular position desired. This position is indicated on the graduated plate on the front end of the trunnion. The table has one solid face similar to the standard design; however, there is a second face which consists of a rocking top set well into the body of the table and having a movement of 15 degrees either above or below the horizontal. Fig. 2 shows this top set in an angular position.

Movement of this rocking top is also controlled by using a crank to operate a worm and the worm-wheel mechanism, and the angular positions are indicated by graduations. A clamping means is provided to hold the tilting top in any position, and at the same time to insure a solid bearing for it. In adjusting the top to the various positions there is no change in the mean distance between the table and the tool-post, and so there is no loss of working distance under the tool. Because there is no outer support, the table has been made of heavier construction than on the "Climax" shaper; for instance, the apron bearing on the rail is 6 inches wider than that on the standard box table.

Either single- or double-screw swiveling vises are furnished. The double-screw vise gives the advantage of clamping taper pieces without the use of extra jaws or shims, whereas the single-screw vise permits a little faster operation. The machine is provided with an automatic power feed for the head, a ball lever being used to engage or disengage this movement. The down feed may be stopped automatically at any desired depth. Various attachments such as index-centers, a circular feeding table, and a cone arbor may be furnished. The method of driving these attachments is shown in Fig. 1, in which a cone arbor is shown on the table. With this arrangement, what was the cross-feed engagement lever now becomes the control lever for the cone arbor, the cross-feed being actuated by hand as needed.

CISCO GEARED-HEAD LATHES

A new selective geared-head lathe has recently been introduced to the trade by the Cisco Machine Tool Co., Cincinnati, Ohio, in 14-, 16-, 18-, 20-, 24-, and 26-inch sizes. Fig. 2 shows the headstock with the cover removed and gives a good idea of the design. All shifting mechanism is contained in the headstock, and as the cover contains no mechanism it can be easily taken off. The two main spindle bearings are constantly supplied with filtered oil through two pockets. End thrust on the spindle is taken by a ball-bearing thrust washer, and wear can be compensated for by means of an adjustable thrust nut.

All gears are made of alloy steel, and the initial transmis-

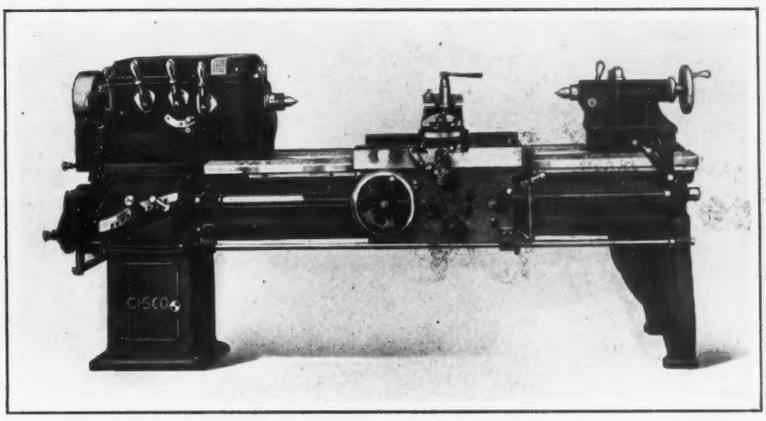


Fig. 1. Cisco Geared-head Lathe

sion or high-speed gears are hardened and ground. All gears are in constant mesh. Twelve changes of speed in geometrical progression are obtained through hardened positive clutches, which have been designed to eliminate clash in shifting from one speed to another, even from the highest to the lowest. All shafts are mounted on ball bearings.

Power is transmitted by means of an adjustable friction clutch into which is built a brake for quick stopping. The starting and stopping of the lathe is accomplished by pulling a handle on either the apron or headstock. The motor drive is of the belted type, with the motor mounted on a plate on top of the head, and a tightening pulley provides for increasing the contact area of the belt and adjusting the tension.

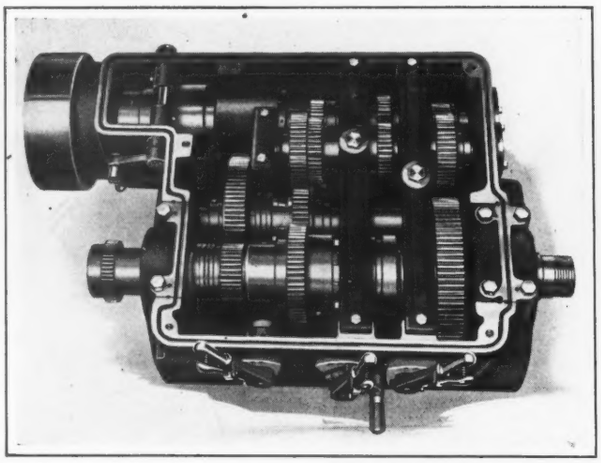


Fig. 2. Geared Headstock of Cisco Lathe with Cover removed

The bed is made of semi-steel, and equipped with two cabinet legs on 20-inch and larger lathes furnished with 12-foot and longer beds. Both longitudinal and cross feeds of the apron are independent, but they are obtained through the same friction and can be reversed in the apron. For rapid production purposes, the lathe can be equipped with a rear-connected tool-block, and diameter and longitudinal stops.

GIDDINGS & LEWIS GRINDING MACHINE

A hand-operated internal grinding machine is the latest addition to the line of equipment built by the Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. In construction, the "Tero," as this machine has been named, incorporates many features of the "Teromatic" brought out about a year ago by the same company. However, the new machine is better adapted to tool-room and other work where but a few pieces of a given size are to be ground. The machine is entirely self-contained, being fully motor-driven. It is universal in that it may be used for grinding straight, blind, and multiple-diameter holes, and also taper holes having an included angle up to 30 degrees. Holes may be ground from ½ inch diameter to a maximum limited by the 16-inch swing over the ways. The work-head carriage consists of an assembly made up of the work-head, a change gear-box, and a one-horsepower motor, as shown in Fig. 2. This entire unit is quickly demountable and easily returned into place in the proper alignment. The work-head spindle may be driven at six different speeds obtained through the change gear-box. Any one of the six speeds is obtained by turning the handwheel to the position indicated for that speed. The motor is equipped with ball bearings and is grease packed. The change-gears run in oil, and the silent chain drive to the spindle is lubricated by the overflow from the spindle bearings. A combined friction clutch and brake in the head disengages and stops the spindle without stopping the motor. The head is swiveled for taper-grinding by means of a micrometer screw. The chucks may be of a large variety for any kind of work, and they are centered and aligned with the spindle by means of a pilot attached to a flange forged on the spindle. The hand-feed wheel is provided with a dial graduated to 0.0002 inch.

The wheel-spindle is driven by an endless fabric belt from a three-horsepower ball bearing motor suspended directly beneath the carriage and reciprocating with it along the machine bed. The wheel-head carriage unit may also be removed from the ways and remounted with ease. Several wheel-spindles, each fitted with a pulley, are recommended to cover the full range of spindle speeds, the spindles being of the ball-bearing type. The wheel-truing device is rigidly held in the working position when in use, but it may be moved away to facilitate gaging, and readily dropped back into place. A one-horsepower motor drives the water pump, which is of the centrifugal type and connected to the motor through a flexible coupling. On withdrawing the wheel from the work, the water is automatically shut off and similarly turned on when grinding is resumed. The swing inside the standard chuck guard is 13 inches, and the maximum travel of the wheel carriage, 21 inches. The weight of the machine is approximately 3700 pounds.

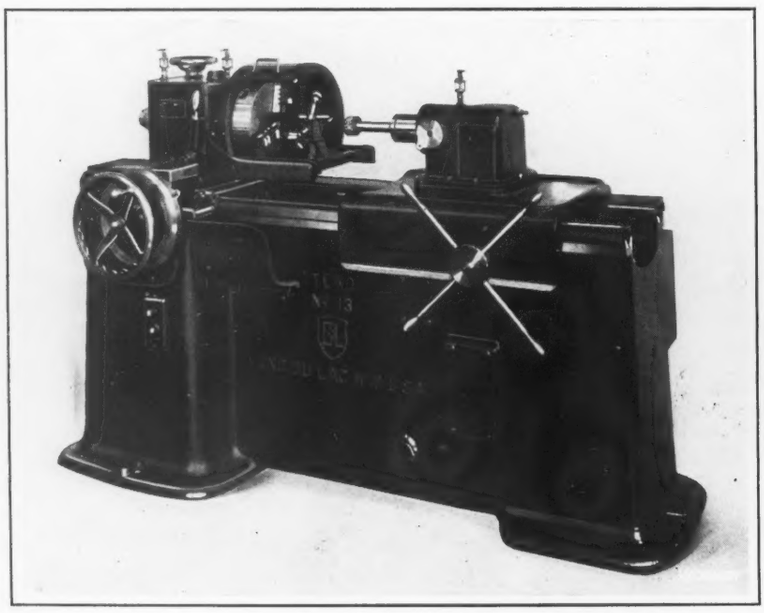


Fig. 1. Giddings & Lewis "Tero" Hand-operated Grinding Machine

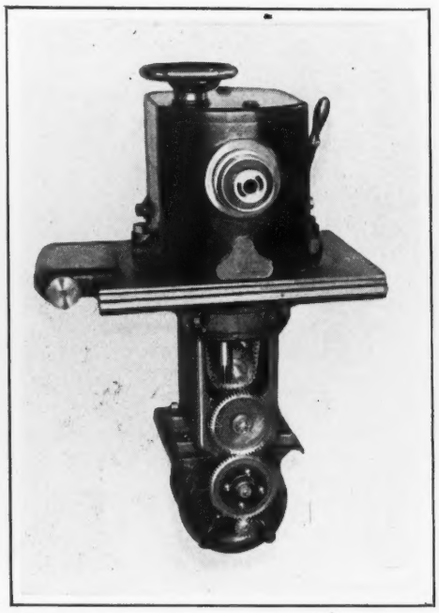
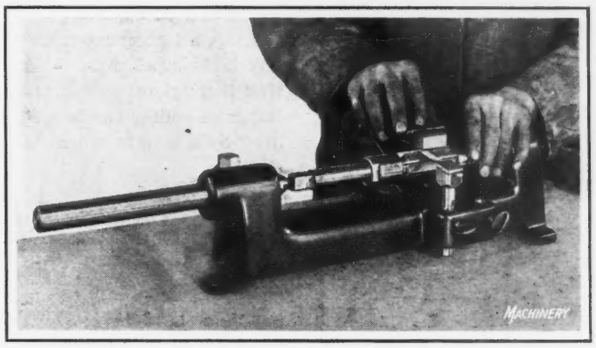


Fig. 2. Work-head Carriage Assembly

FOSTER-JOHNSON REAMER SHARPENER

Both adjustable and solid reamers may be kept in first-class condition with keen cutting edges by the use of a simple machine introduced to the trade by the Foster-Johnson Reamer Co., Elkhart, Ind. In this device the reamer is held on two adjustable dead centers, as shown in the illustration, a tooth-rest on the rear side of the machine holding the reamer blades in the correct position for sharpening. On the front side is an adjustable support for a hone carrier, and by raising or lowering this support, the hone can be brought to conform to the correct cutting angle of the reamer blades. The blades are sharpened by moving the hone back and forth across them. This No. 1 reamer sharpener is designed to handle the general run of reamers in the average tool-room, machine shop, and automobile service station, and will accommodate reamers up to 2½ inches in diameter. The maximum and minimum distances between the centers are 12¾ and 4 inches, respectively. The weight of the equipment is about 25 pounds.



Foster-Johnson Sharpener for Solid and Adjustable Reamers

CHAMBERSBURG MOUNTING AND DEMOUNTING WHEEL PRESS

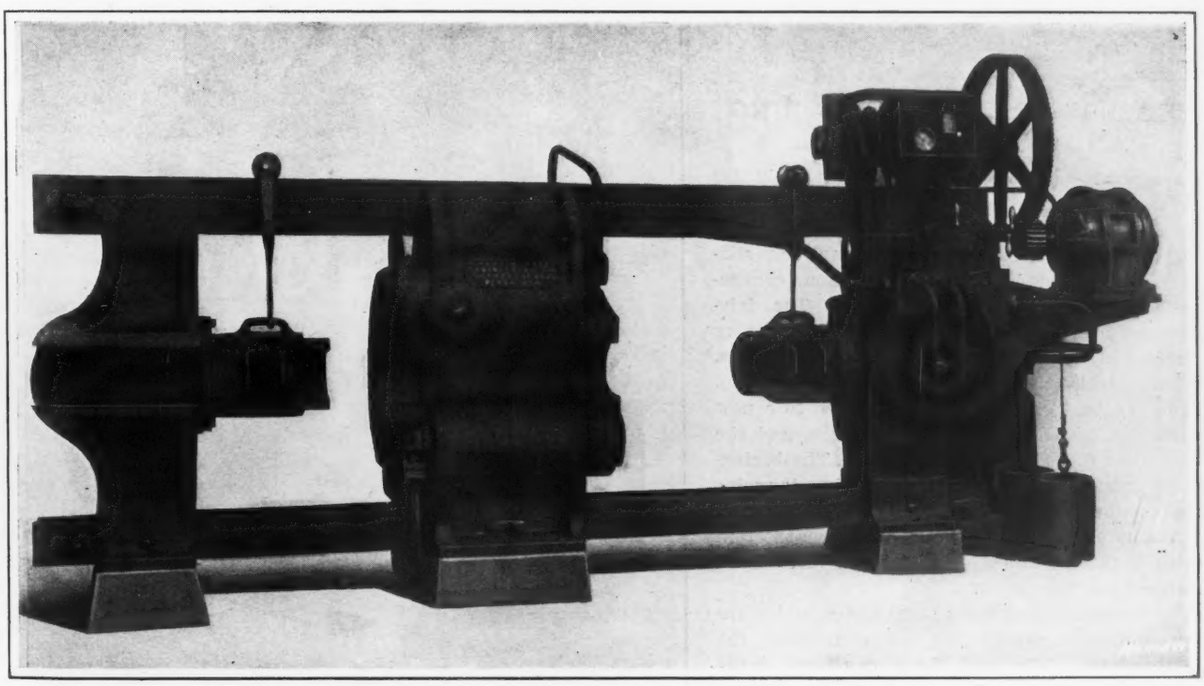
A patented mounting and demounting car-wheel press designed especially for use in railroad and car shops has been developed by the Chambersburg Engineering Co., Chambersburg, Pa. The features claimed for this press are simplicity of design, ease of control, and low cost of operation. It is built in two sizes, one of which has a capacity of 200 tons for mounting and 400 tons for demounting, and the other, 300 tons for mounting and 600 tons for demounting. The press will force both wheels on or off an axle either simultaneously or one at a time. It is automatic in operation.

All the beams are stationary and provided with large bases so that the press can be bolted directly to a concrete foundation. The necessary adjustments for pressing wheels on or off are made by means of small light forcing blocks and sleeves suspended from a trolley. The cylinder beam at the right-hand end contains the ram for pressing wheels on axles, and the center cylinder beam is used for pressing wheels off axles. The center beam contains four rams, two for each right and left cross-head, and these are provided with safety valves so that when the plungers reach an outward stroke of 12 inches, the valves "blow off" and prevent over-travel. The resistance beam at the left-hand end takes the thrust when forcing wheels on or off. It is equipped with a removable steel facing head, and is recessed to permit of handling long shafts in the machine. Two assembling trucks on a track and a screw jack are furnished for use in loading and unloading this machine.

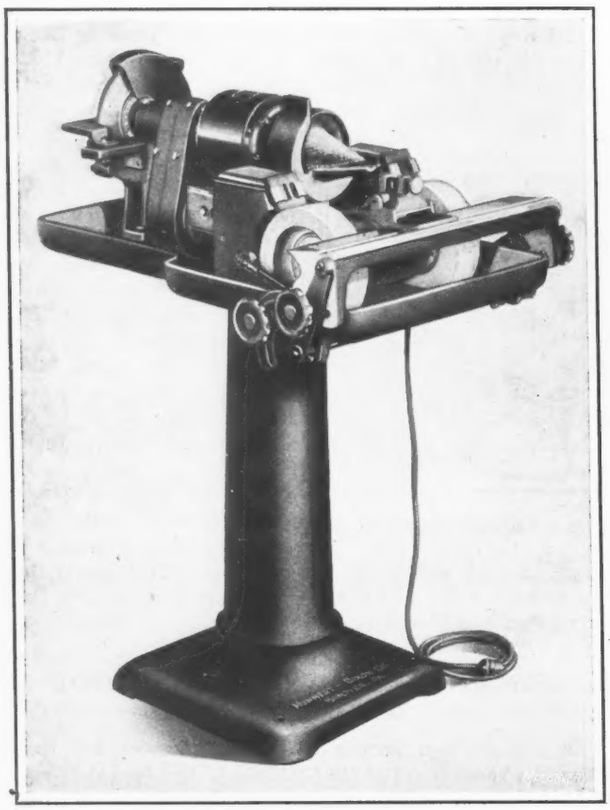
MUMMERT-DIXON OILSTONE TOOL GRINDER

An oilstone tool grinder which incorporates five basic units and hence is called the "Plurality," has been developed by the Mummert-Dixon Co., Hanover, Pa. These five units comprise two coarse and fine oilstone wheels, a grinding cone, a leather stropping wheel, and an emery wheel, and all of these units are accessible from two adjacent sides of the machine. The equipment is direct motor-driven and furnished with ball bearings throughout. It is intended to meet the requirements of all kinds of woodworking shops for rapidly sharpening such tools as plane bits, chisels, gouges, and various bench tools.

The motor is mounted on top of the housing and connected to the emery-wheel shaft by a non-rigid coupling, the oilstone arbor being driven through a chain of gears enclosed in oil-tight cases. The oilstone wheels are kept saturated with kerosene which is supplied from two reser-



Chambersburg Press designed for forcing Wheels on or off Axles in Railroad and Car Shops



Mummert-Dixon Oilstone Tool Grinder

voirs and driven out through the pores of the wheels by centrifugal force. This method keeps the wheels clean, eliminates glazing and obviates heating of the tool being sharpened. Special appliances prevent an over-accumulation of oil on the face of the wheels and keep it from flying off. The coarse oilstone wheel is intended for rapid grinding, and the fine wheel for putting a smooth, clean cutting edge on tools. The leather stropping wheel is intended for removing wire edges and giving finishing touches to tools, the grinding cone for grinding gouges and irregular shaped tools, and the emery wheel for general dry grinding. The net weight of the equipment is about 275 pounds.

SELLERS DRIVING-BOX BORING AND FACING MACHINE

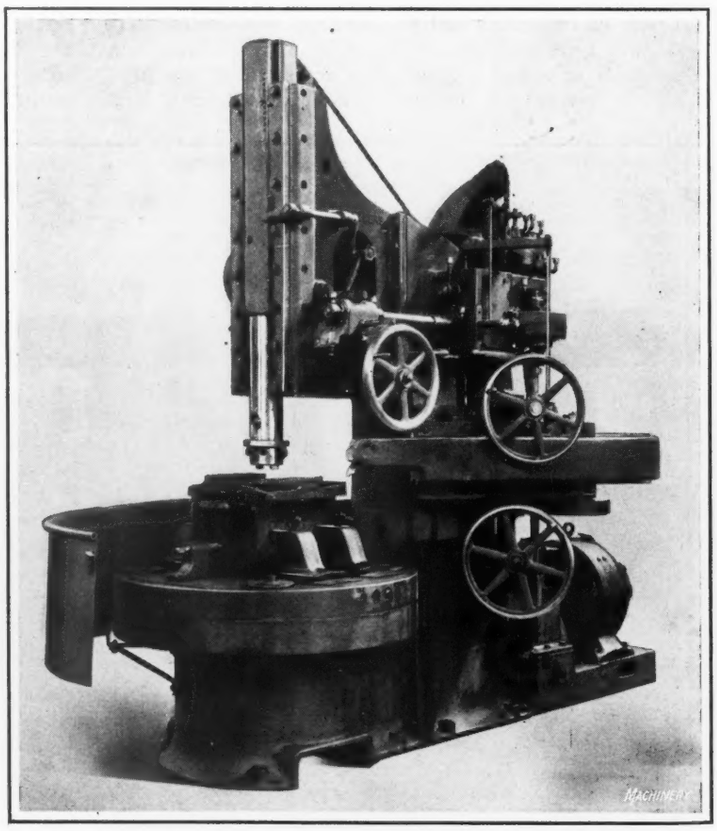
A special-purpose machine intended solely for boring and facing locomotive driving-boxes has recently been developed by William Sellers & Co., Inc., Philadelphia, Pa. It is a comparatively simple machine tool of heavy construction, conveniently arranged and easily operated. The driving-boxes are mounted in a special self-centering chuck, and bored and faced at the same time, which reduces the cutting time to a minimum. When required, a driving-box is shifted to a new center while still clamped in the chuck, and the edges are relieved to give clearance. The boring-bar is carried by a long steel slide of rectangular cross-section, and the boxes are faced by means of a horizontal arm of rectangular cross-section which is carried in a slide that has a vertical adjustment on the upright.

The guides for the boring and facing slides are long, and shoes provide for taking up wear, the length of the slides and the proportions of the bearings insuring accuracy and also durability. There are power vertical and horizontal feeds, respectively, for the boring and facing rams. The table revolves on an annular bearing which is well lubricated. There is a large center spindle for the table, with a taper bushing provided with adjustment for wear. A collar at the lower end of the spindle prevents lifting under heavy facing cuts. The chuck is so designed that boxes can be bored and faced, the edges relieved, and an oil space cut in the top, all at one setting of the jaws and without loosening any bolts or clamps, the box being held in its original position throughout the series of operations. Two sets of clamping jaws center the box sidewise, and all four jaws are operated by a single crank. A stop is provided for the top of the box.

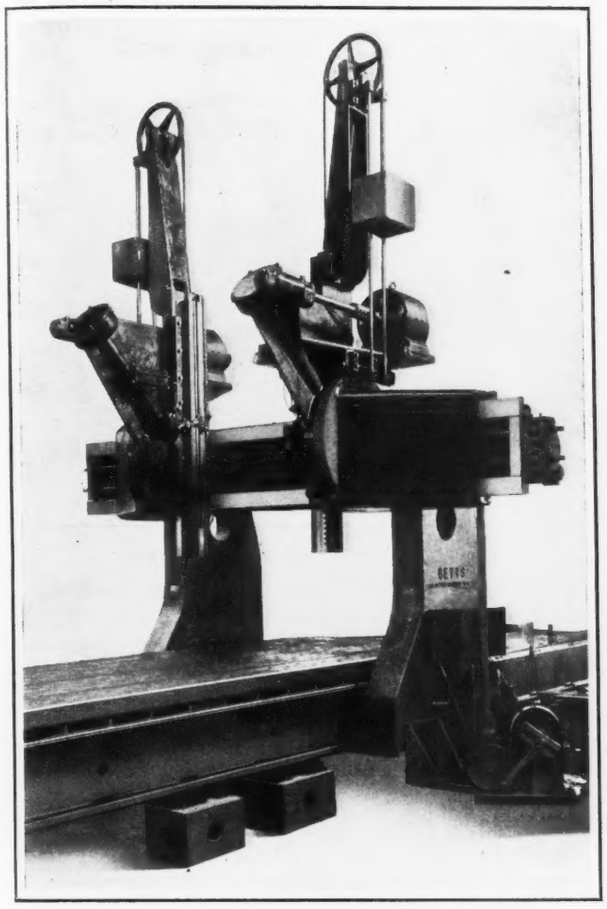
The boring-bar was developed especially for use in this machine. It is equipped with two sets of cutters—a double-end cutter for roughing, and a single-end cutter for finishing. Both sets of cutters have micrometer adjustments and means for clamping securely in position. It is preferable to drive the machine by a variable-speed direct-current motor, not only on account of the ease in changing speeds and the small variations in speed obtainable, but also because of the convenience of dynamic braking for quick stopping. If direct current is not available, the machine may be provided with a speed-change box and driven by a constant-speed alternating-current motor, or with a single pulley.

BETTS PLANER-TYPE SLOTTER

A large special machine tool of unusual design has recently been built by the Betts Machine Works, Rochester, N. Y., of the Consolidated Machine Tool Corporation of America for use in a plant manufacturing railway specialties. As will be noted from the illustration, the bed and table are of conventional design, but two slotting rams are mounted on the cross-rail. The bed has one V- and one flat way for guiding the table and the ways of the latter are automatically lubricated by oil pockets and rollers. The table has T-slots and stop-holes for conveniently clamping the work. Fastened to the bed are two heavy uprights car-



Sellers Boring and Facing Machine for Locomotive Driving-boxes



Betts Slotter with Bed and Table of Conventional Planer Design

rying a fixed cross-rail of wide face, which is deeply arched at the back. On the cross-rail are two saddles which, in turn, support the slotting rams. Owing to the fact that provision must be made for angular slotting, these rams face each other, and as the saddles swivel, it is possible to slot at a maximum inclination of the rams of 2 inches per foot. The saddles are swiveled by means of a worm and segment.

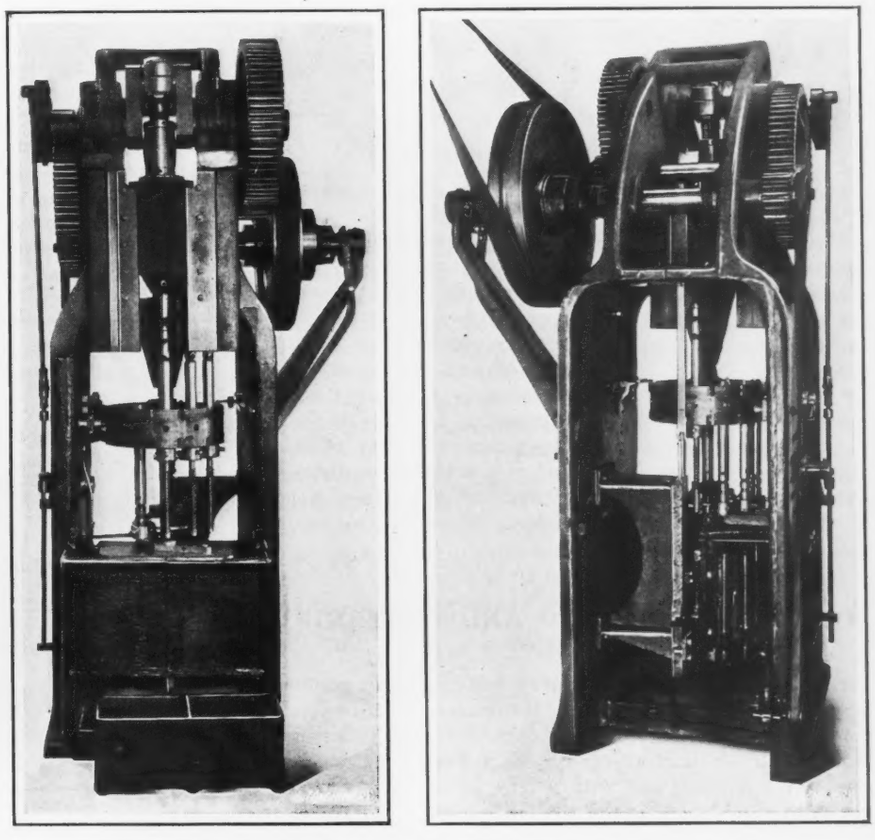
Each ram is driven by a 20-horsepower reversing planer-type motor, equipped with a full automatic control, and provision is made, by electrical synchronization, for keeping both rams working in unison. The motor for each ram is mounted directly on the saddle, and the rams are driven by the Betts angular-shaft drive in which a special multiple-thread worm meshes with a straight-tooth rack. The ram cutting and return speeds are adjustable by means of planer-type control panels. Each ram is counterweighted by a guided sliding weight.

Each saddle has a feed and power rapid traverse along the cross-rail, and both of these movements are obtained from a 15-horsepower motor. Provision is made for selecting the feed or the power rapid traverse and for engaging or disengaging either of these mechanisms from the operator's position on the floor, which adds to the convenience of operation in view of the height of the machine. All important saddle bearings have forced-feed lubrication. The feed and power rapid traverse of the table are obtained from the same motor that actuates the saddles on the cross-rail, an interlocking arrangement being provided so that the saddle and table cannot be moved at the same time. The machine has a capacity of 10 feet 2 inches between the housings and 5 feet under the saddles, and the slotting rams have a 48-inch stroke. The table is 30 feet long between the pockets and is 9 feet wide.

MYERS AUTOMATIC BROACHING MACHINE

A broaching machine in which as many as twelve broaches may be passed successively and automatically through the work has been developed by the Myers Machine Tool Co., Mount Clemens, Mich. The broaches are fed vertically from an overhead intermittently indexing turret. While in the raised position and during the feed, each broach is held in a chuck attached to the lower end of a sliding spindle in the turret. However, as the broach is passed through the work it is gripped by a collet on a drum beneath the table, and when the operation has been completed, the chuck on the upper turret spindle opens and allows the broach and lower collet to drop sufficiently on the bottom drum to permit of indexing the latter.

The turret and lower drum are mounted on the same vertical shaft at the center of the machine, as shown in Fig. 2, and thus are indexed in unison. The different broaches simply rotate with the upper turret until they are indexed under the ram of the press, which, at each descent, forces down the upper end of the sliding spindle to push the corresponding broach through the work. As each broach on the lower drum reaches the mechanism seen at the rear of the machine, it is automatically lifted into engagement with the proper chuck on the overhead turret spindle. Fig. 1



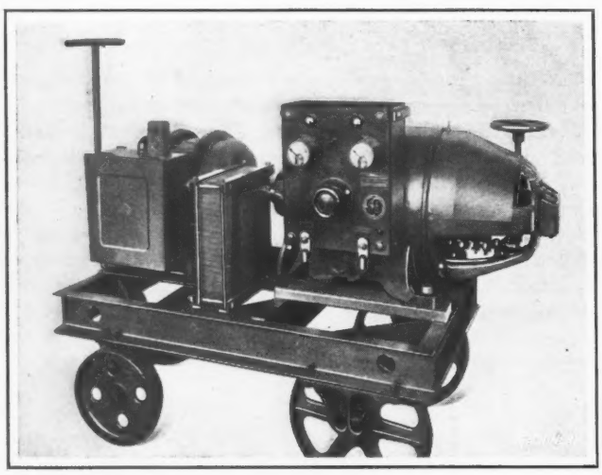
Figs. 1 and 2. Front and Rear Views of the Myers Automatic Broaching Machine

shows most of the broaches raised, while in Fig. 2 all but one of them are on the bottom drum. Both the turret and the bottom drum are designed to carry twelve broaches 1 foot long.

A high rate of production is claimed for the machine; on small parts in which splined holes are broached, the output averages nine pieces per minute. Automatic stops on the press function in case a broach breaks or accidentally fails to be released. As the finishing broach becomes worn it may be used for the next to the last broach and so on down the entire group.

GENERAL ELECTRIC PORTABLE ARC WELDER

A portable arc welder designed to insure a smooth and rapid deposition of metal, with thorough penetration, has been placed on the market by the General Electric Co., Schenectady, N. Y. It is said to deliver continuous power and permit rapid production, both with a high current and large electrodes and with a low current and small electrodes. This welder is a two-unit set consisting of a motor and a generator. The generator is self-excited so as to eliminate the necessity of a separate exciter, and all regulation of current is accomplished by turning a handwheel on the



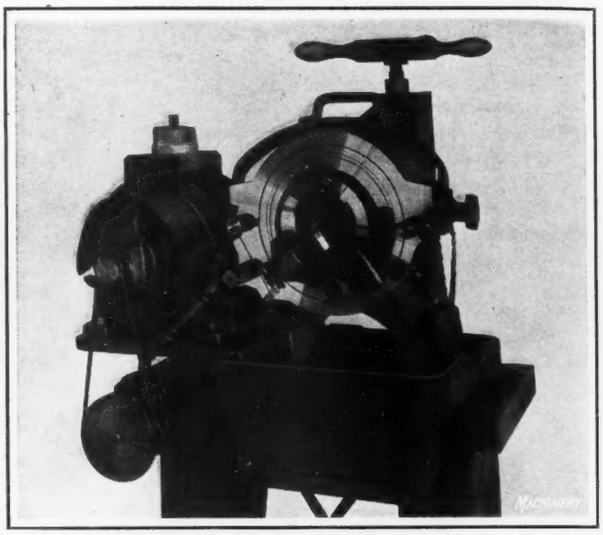
General Electric Portable Arc Welding Equipment

generator. A self-adjusting stabilizing reactor is provided to steady the arc under all welding conditions.

The welder can be used with any commercial size of metallic electrode from 1/16 to 1/4 inch in diameter. The generator voltage can be adjusted to suit the character of the work, high voltage being used for complete penetration on heavy work and low voltage to prevent burning through light work. Any current between 75 and 300 amperes can be obtained in a large number of steps. Among the advantages claimed for this outfit are an arc easy to start and maintain; the adaptability of the equipment to long or short leads for working close to a set or at a distance from it; roller bearing wheels; and the provision of holes in the base to receive crane hooks. The total weight is about 1600 pounds.

FORBES PIPE CUTTING AND THREADING MACHINE

The Forbes portable pipe cutting and threading machine built by the Curtis & Curtis Co., 324 Garden St., Bridgeport, Conn., which was described in December, 1921, MACHINERY, is now built, as illustrated, with the motor on the opposite side of the machine and with several other improvements. By placing the motor at the left, as viewed in the illustration, the pinion presses up on the gear instead of down.



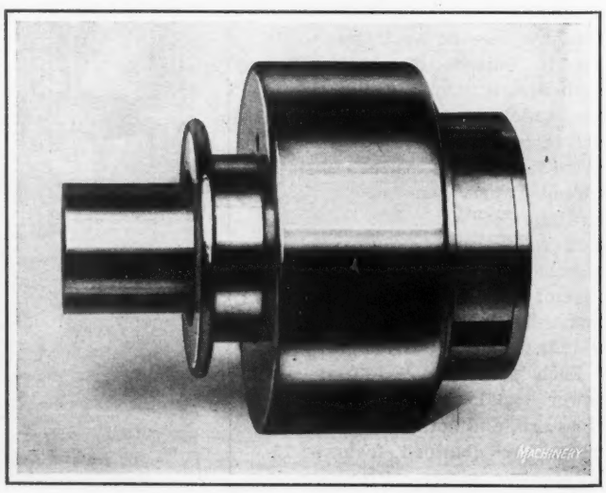
Forbes Pipe Cutting and Threading Machine

This is said to eliminate wear on the bottom of the shell, and make the operation of the machine easier.

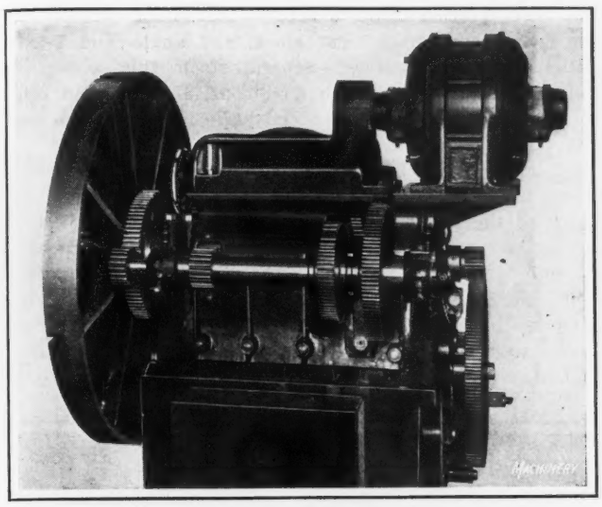
The improved machine is equipped with a three-point vise, which enables all sizes of pipe to be held and obviates the use of the flat jaws necessary with the older style. It is provided with self-oiling devices, which pump oil into the head of the machine for delivery directly in front of each die. The oil also serves to wash chips out of the machine and thus keep it clean. The machine is made in two sizes, a 2-inch, weighing about 350 pounds, and a 4-inch, weighing about 500 pounds.

H & G DIE-HEAD

A style AA die-head designed for use on machines such as the Acme automatic, where the die-spindle rotates in threading and the stock does not, has been developed by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn. There is an accurate adjustment for the length of thread cut that is positive in its action. The die-head is closed by compression brought about by the backward movement of the die-spindle. There is an outer shell provided with a spool at the back to take a yoke, and when the forward motion of this yoke is stopped, the die-head is immediately tripped. The die-head is automatically closed when the threading spindle is drawn back, and the backward motion of the yoke arrested by means of a stop. The design of this die-head simplifies its installation and eliminates trouble from short ends.



H & G Die-head for Acme Automatics and Other Machines of Similar Design



Rahn-Larmon Geared Faceplate Drive for Lathes

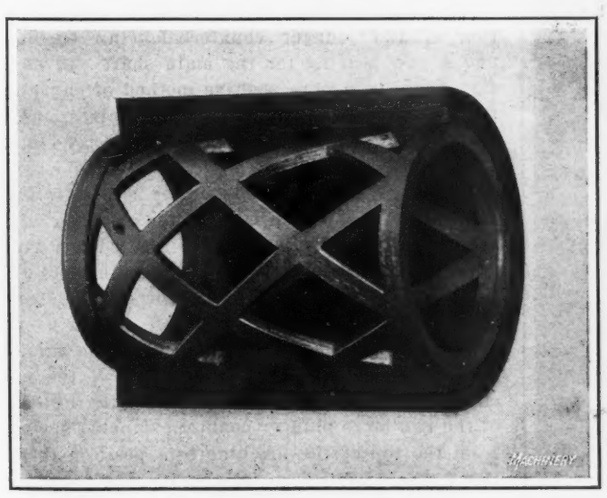
RAHN-LARMON FACEPLATE LATHE DRIVE

A geared faceplate drive is now being provided on the 22- to 40-inch, 24- to 48-inch and 28- to 48-inch extension bed gap lathes built by the Rahn-Larmon Co., Cincinnati, Ohio. The drive is direct from the back-gears to a gear on the large faceplate, the driving shaft of the back-gear being extended, and a pinion on the faceplate end meshed with a large steel gear which is fitted on the hub of the large faceplate. This arrangement steadies the cut on large-diameter work, because the drive is close to the surface being turned, and hence heavier cuts can be taken without chatter.

The pinion that drives the faceplate gear can be slid out of mesh toward the adjacent back-gear arm when the large faceplate is not being used. Shifting the pinion to either the in or out position is accomplished by manipulating the handle at the rear end of the headstock which is clearly seen in the illustration. Thus the small driver plate, the regular small faceplate, and the regular chuck can be used without having the back-gear shaft and pinion project and interfere with the work. All gears are made of steel and are properly guarded.

UNIVERSAL SELF-LUBRICATING BEARINGS

Various types of self-lubricating bearings consisting of hard maple reinforced by babbitt metal are now manufactured by the Universal Self-Lubricating Bearing Corporation, Lincoln, N. J. The illustration shows a cylindrical bearing with the wood portion cut in two so as to show the arrangement of the reinforcing on the inside. In a bearing of this design, grooves are cut into the bearing surface of the wood portion and the babbitt cast into place. It will be noted that there is a circular groove cut in each end of the bearing so as to provide for a continuous strengthening ring of babbitt at the ends. After the babbitt has been cast, the bearing is reamed smooth.

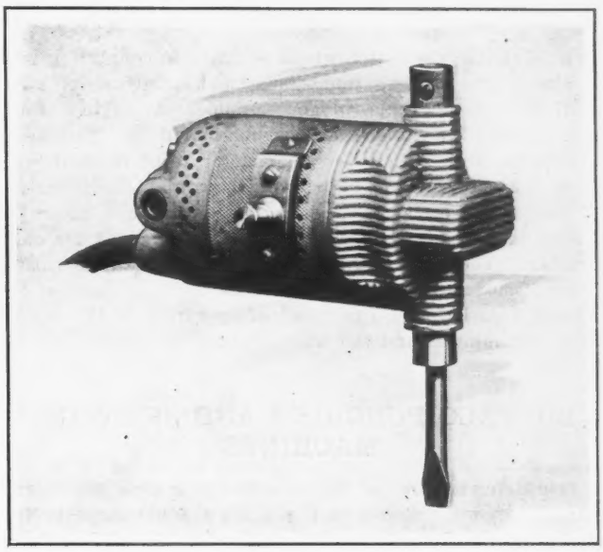


Universal Self-lubricating Bearing

The wood shell is impregnated with lubricants and thus serves as an oil reservoir to exude lubricant in quantities said to depend upon the amount of friction. Bearings of this type are also made with a flange at one end. Other styles include friction disks and thrust washers of a number of designs in which the babbitt is cast in circular grooves on the contacting faces of the disks and connected by solid slugs of metal cast in holes extending from one side of the disks to the other.

STEPTOE ELECTRIC SCREWDRIVERS

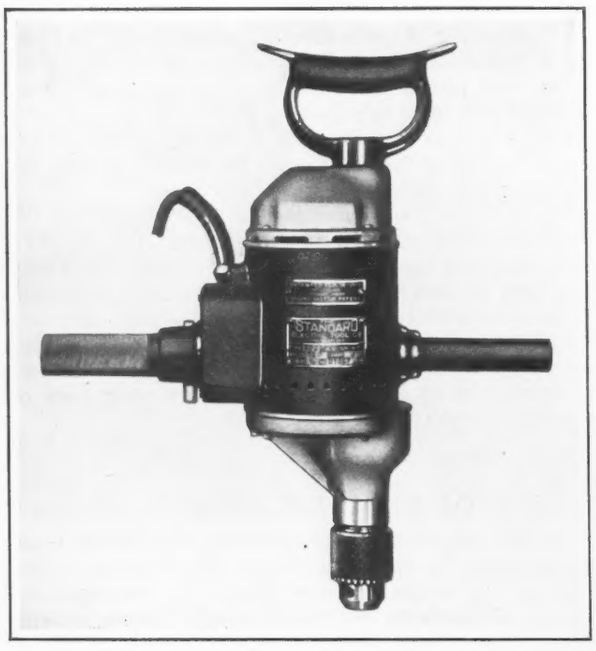
The portable electric screwdriver here illustrated is now manufactured by the John Steptoe Co., Cincinnati, Ohio, this concern having recently acquired the manufacturing and selling rights for the line of portable electric tools formerly made by the Automatic Electric Tool Co. of the same city. This line includes screwdrivers, lag screwdrivers, drills, bolt and nut tighteners, etc. The screwdriver is now equipped with a special switch which prevents the motor from b ing overloaded. When the motor is subjected to a greater pressure than its rated capacity, the switch automatically shuts off the current and prevents damage to the motor parts. As it weighs only 5 pounds, it is especially suited for use in the manufacture of furniture, automobile and truck bodies, electric switchboards, and many similar products. It is provided with a pistol grip handle and bit, and may be used either for driving in or taking out screws. The automatic lag screwdriver is especially handy for the millwright. That tool is also provided with the improved switch, and weighs about 30 pounds.



Steptoe Portable Electric Screwdriver

PORTABLE ELECTRIC DRILL

An improved electric drill known as the "Standard Special Type 4 UG" is being placed on the market by the Standard Electric Tool Co., Cincinnati, Ohio. The new drill is equipped with ball bearings, each of which is encased in grease in a dustproof chamber. It is also provided with a Jacobs chuck which contacts with a thrust bearing. There



Portable Drill made by the Standard Electric Tool Co.

is a special toggle switch which is fitted, in connection with a plunger, to give an immediate "make and break." The drill also has an improved brush-holder at the top of the motor frame and a special bearing mounting. The gears are of the stub-tooth type. The motor is of the universal style for operation on both alternating and direct current of the same voltage. All electrical connections enter the frame unit, and so both handles can be removed for close drilling. The tool can also be furnished with a carbon brush remover and a special arbor for holding small emery wheels, chisels, etc. The speed of operation is 475 revolutions per minute, and the weight, about 17 pounds.

BUFFALO PUNCHING AND SHEARING MACHINES

Five different sizes of the combination punch, shear, and special bar-cutter shown in Fig. 1 are manufactured by the Buffalo Forge Co., 144 Mortimer St., Buffalo, N. Y. These machines are specially adapted to repair work, because of the universal bar-cutter arrangement, which can be used for round, square, and flat stock, and angle- and T-irons without changing knives. Separate from this section are knives used for cutting channel-irons, I-beams, and other rolled pieces. However, a special knife is required for each size of channel iron and I-beam.

Of importance when a considerable amount of punching is required in the shop, is the arrangement whereby the knife on the shear end can be replaced by punching tools so that both ends of the machine can be used simultaneously for punching. The shearing arrangement is different from that incorporated in the standard machines built by this company in that the placing of the shear knife at right angles to the frame necessarily limits the width of sheet that can be sheared to the depth of the throat.

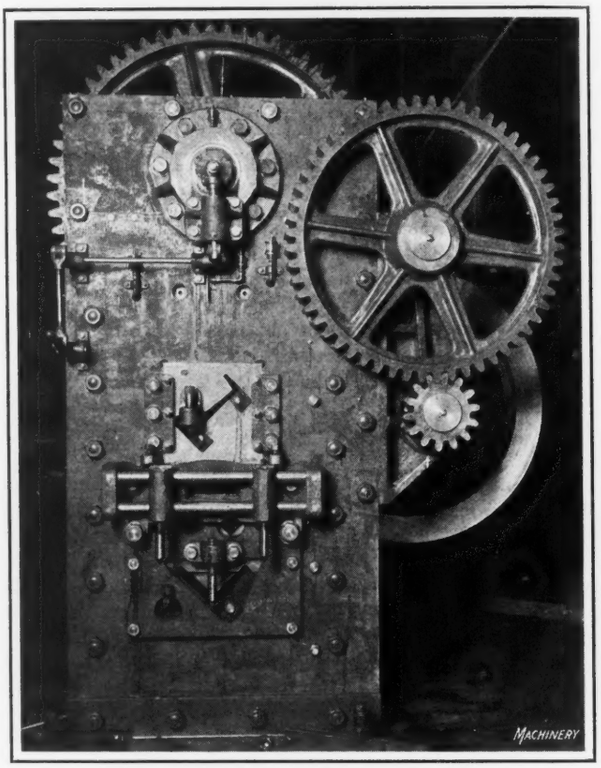


Fig. 2. Buffalo Bar-cutter of a New Series

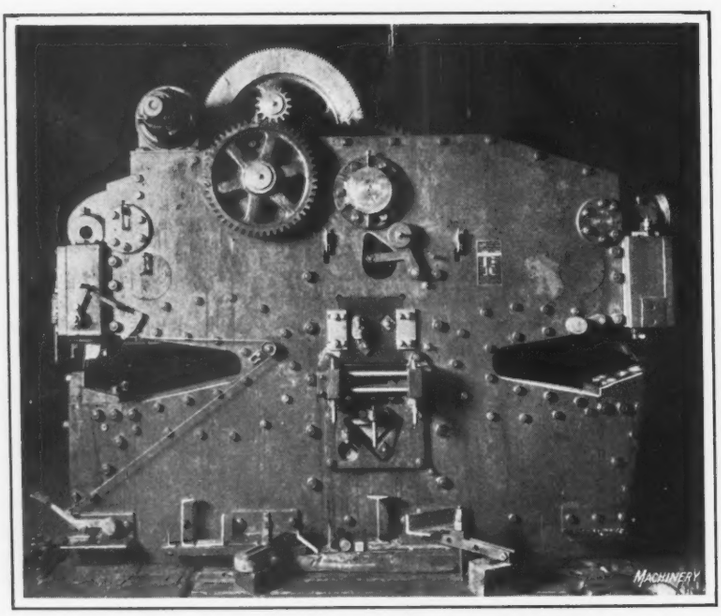


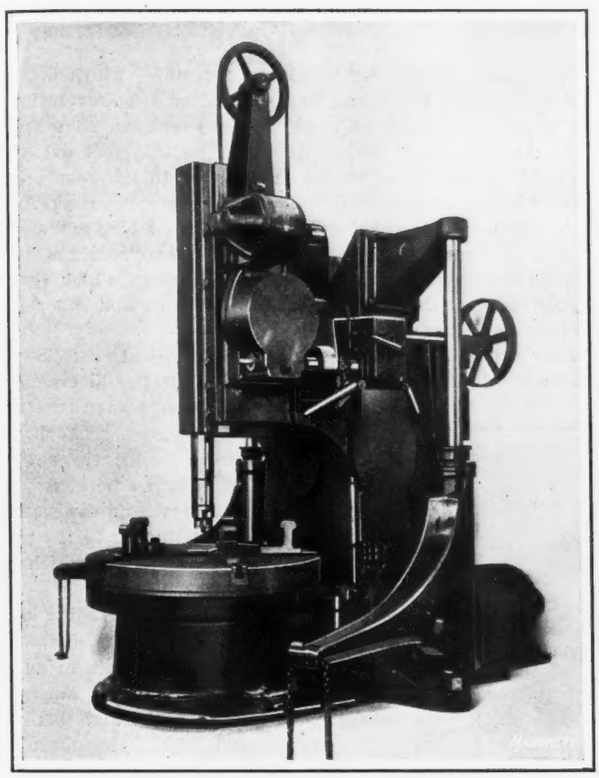
Fig. 1. Buffalo Combination Punch, Slitting Shear, and Bar-cutter of New Design

Fig. 2 shows one of a new series of special bar-cutter machines also recently brought out by the Buffalo Forge Co. The improvements common to all machines of this series include a universal bar-cutter arrangement with a special section for cutting channel-irons and I-beams; a better location of the plunger counterbalancing springs; and a new bearing for the main shaft. In addition, there is a more positive method of engaging the plunger on the smaller sized machines, and a new type of cam adjustment for the jaw-clutch of the larger machines.

The lower half of the bar-cutter section is also so designed that it can be used for cutting round, square, and flat stock and angle- and T-irons without changing knives, while the upper-half of the section contains knives for cutting channel-irons, I-beams, and other rolled sections. Again a special knife is required for each size of channel-iron or I-beam. The over-all height of the machine has been reduced by changing the location of the two large plunger counter-balancing springs from the top of the machine to a position inside the frame. With the new drive-shaft bearing, either the flywheel or the shaft itself can be quickly removed when necessary.

BETTS CAR-WHEEL BORING MACHINE

The car-wheel boring machine built by the Betts Machine Works, Rochester, N. Y., of the Consolidated Machine Tool Corporation of America, which was described in January MACHINERY, may now be equipped with double pneumatic hoists and a motor-driven power rapid traverse to the boring spindle as here shown. In the illustration presented in connection with the previous description, the machine was equipped with a mechanical hoist, and the power rapid traverse was driven by belt from the main driving shaft. Another improvement on the machine here shown is that all table speeds are obtained electrically from a variable-speed motor, whereas on the other machine they were obtained through sliding gears operated by means of shifter levers.

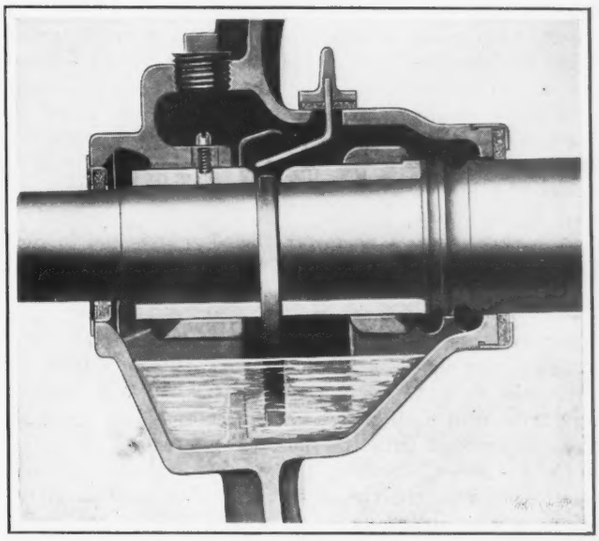


Betts Car-wheel Boring Machine

Starting and stopping of the table and opening of the chuck jaws on the machine here shown are all accomplished instantly by means of a push-button control, and the motor speed is also adjusted instantly by means of a separate field rheostat. The pneumatic hoists are entirely independent, and each one will swing to the center of the table, an arrangement that facilitates loading and unloading car wheels, since it permits them to be handled from either side of the machine. The power rapid traverse is controlled by a conveniently located push-button station which actuates the automatic controller. An interlocking clutch between the feed and power rapid traverse mechanisms insures that both cannot be engaged at the same time.

WESTINGHOUSE LEAKPROOF MOTOR BEARING

An electric motor sleeve bearing designed to prevent the leakage of oil into the windings or the entrance of dust and grit into the bearing has been developed by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. This bearing is known as the "Sealed-Sleeve." A connecting passage in the upper part of the bearing housing results in a balanced air pressure in the separate chambers into which the housing is divided by the bearing supports. The action of the blower at high speeds sets up a vacuum next to the inside end of the housing, and since it is impossible to seal the housing absolutely at that point because of the shaft, the vacuum extends to the space within the housing itself. If the upper passage were not provided, an unbalanced air pressure would result whenever the oil level rose high enough to close the lower cored openings.

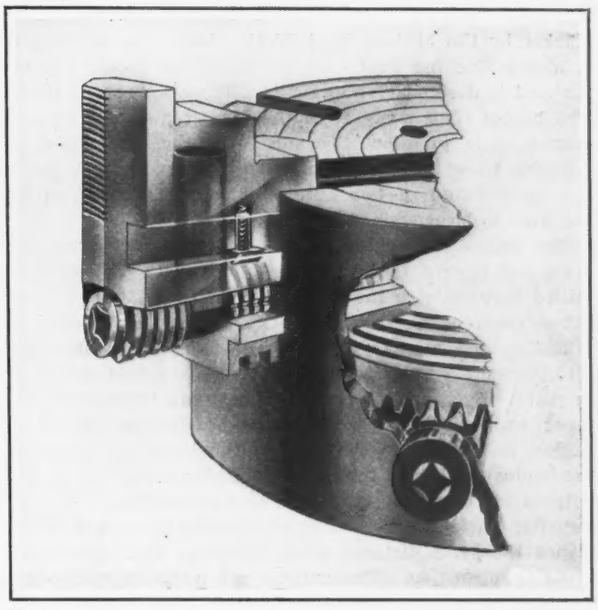


Westinghouse Sealed-sleeve Motor Bearing

A large air-tight threaded pipe plug is provided to permit inspection of the oil-ring, and a cover bolted over the oil-ring slot is made air-tight by the use of oilproof packing. An enclosed combination filling and overflow opening is placed in the side of the bearing. Where the shaft passes through the bearing, an improved method is used to support a felt dustproof washer. The bearing requires oiling only once or twice a year.

CUSHMAN "TRI-PLEX" CHUCK

A chuck having both universal and independent jaw movements which automatically indicate when the jaws have found a common center is being placed on the market by the Cushman Chuck Co., Hartford, Conn. The chuck action may also be quickly changed from concentric to eccentric by simply turning the screw of a jaw with a wrench. Be-



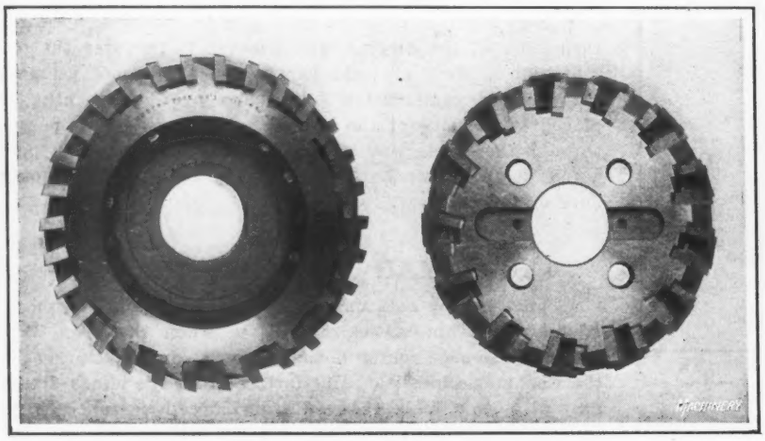
Phantom View of Jaw on Cushman "Tri-Plex" Chuck

cause of these features the chuck has been termed the "Tri-Plex." It is made in sizes ranging from 9 to 15 inches. From the phantom view of the jaw shown in the illustration it will be seen that at the base of each jaw is a hardened screw encircled by a thrust bearing. The screw engages the steel rack beneath it and the lower surface of the rack meshes into a scroll. When this scroll is revolved by means of a pinion, all racks are carried concentrically forward or backward.

On each screw is a narrow V-shaped groove, and in each jaw is a spring-index pin which rides over the screw as it is turned, until the pin engages the groove. As the pin clicks into place after a full turn of the wrench, the operator knows that he has moved the jaw 0.200 inch. The index-pin will ride in and out of the groove with little obstruction. To make the chuck concentric, all that is necessary is to turn each screw whose jaw has been given an eccentric position until the index-pin clicks into the index-slot of the screw, observing at the same time that the ends of all jaws are approximately in the same relation to the same circular observation line on the face of the chuck body.

INSERTED-TOOTH FACE MILLING CUTTERS

Inserted-tooth face milling cutters in which all parts of the cutter-head or body are hardened and ground so as to maintain accuracy in use, have recently been placed on the market by the Modern Tool Works, Erie, Pa., of the Consolidated Machine Tool Corporation of America. The cutter-head is designed for either stellite or high-speed blades. The blades slope away from the largest diameter at a 20-degree angle to allow clearance over the clamps for the grinding wheel to pass when sharpening, and also to permit the interlocking of two cutters when finishing a surface too wide to be machined by one cutter.



Front and Rear Views of Milling Cutters made by the Modern Tool Works

The blades are located in the cutter body at an angle of 6 degrees toward the cut or line of travel. The slots are milled parallel with the bore when stellite blades are used, but when high-speed blades are employed, the slots are milled at an angle to give a rake. A two-piece clamp drawn into place by a taper wedge bolt is used to hold the blades in place. Each slot takes two blades, and between these a taper wedge is fitted with clamps bearing on top of the blades, so that when the nuts of the bolts are tightened, the blades are locked solidly. The blades are provided with notches in the bottom which fit over a stop-pin. This construction backs up the blade and provides for advancing all blades the same distance when adjusting them prior to a grinding operation. The cutters are made in coarse- and fine-pitch styles, and in sizes from 4 to 16 inches, larger diameters being made special.

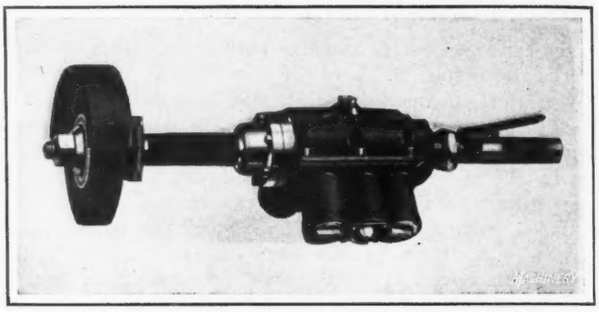


Fig. 1. Cleveland Pneumatic Air Grinder

"CLECO" PNEUMATIC GRINDER AND MOTOR

A portable air grinder weighing 12 pounds, which drives a 6-inch emery wheel and has a speed of 4600 revolutions per minute is being brought out by the Cleveland Pneumatic Tool Co., Cleveland, Ohio. An arbor on this tool extends forward for use as a handle in addition to the rear grip. This arbor is connected directly to the driving crank, and it is mounted on annular ball bearings at both ends, as is also the crank. In addition to these ball bearings, the single-piece connecting-rods contain ball races which operate directly on the crank. All ball bearings and other revolving parts are continuously lubricated.

Four types of throttle handles are furnished as follows: Enclosed handles with outside or inside throttle levers, and straight handles with either a snap throttle lever or a twist throttle sleeve. The body is split at the center to permit the entire crank assembly to be removed without disconnecting pistons or valves from the crank. The connecting-rods are attached to the piston sockets by a floating wrist-pin which is perforated for lubrication.

The same company is also bringing out the air motor shown in Fig. 2, which was designed to meet the requirements of such railroad work as drilling, reaming, tapping, flue-rolling, and setting plain and flexible staybolts, sleeves, and caps. The outfit is built in both plain and compound geared types. All moving parts of this equipment are also mounted on ball bearings. The motor is of the four-cylinder type with four single-acting pistons connected to opposite wrists of a double-throw crank. The wrists of the crank are grooved, hardened, and ground to act as inner ball races, and the connecting-rods are machined to serve as outer races. The main valves of the motor are of the sliding piston type and are operated from eccentrics on the crankshaft. The design is such as to permit injecting live air almost instantly into the piston chamber to give a quick motor action and conserve air.

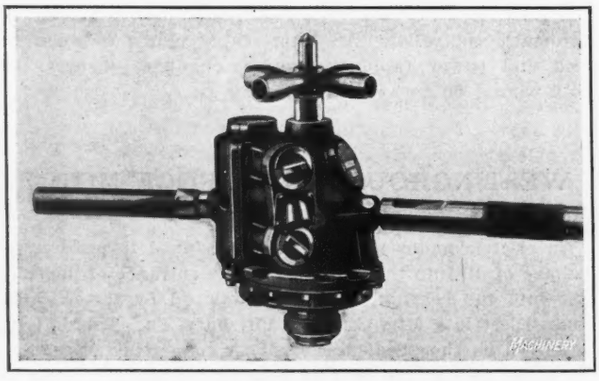
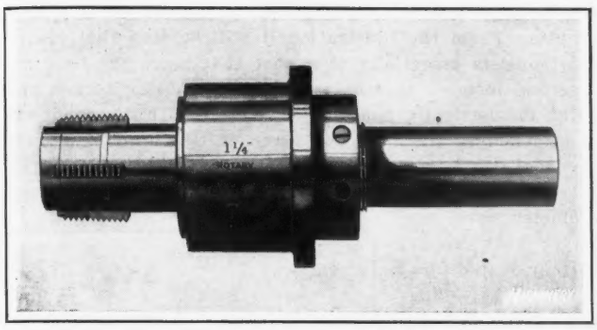


Fig. 2. Air Motor for drilling, reaming, tapping, etc.



Geometric Adjustable Collapsible Rotary Tap

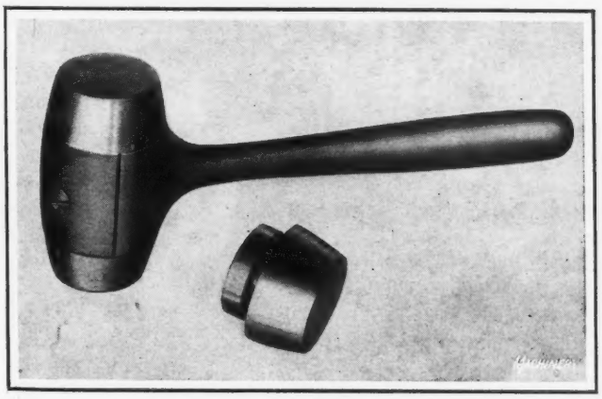
GEOMETRIC ADJUSTABLE COLLAPSING ROTARY TAP

A class HB rotary tap for use on drilling machines, multiple-spindle automatics, and other machines where a tap of the rotary type is required, is being introduced to the trade by the Geometric Tool Co., New Haven, Conn., in any diameter from 1 inch up. The chasers may be expanded without slowing down or stopping the machine spindle, and may be removed after taking off the cap on the front of the tool. The tap is provided with a flange trip that is operated by coming in contact with closing forks or a collar attached to the machine, the opening and closing of the tap being controlled by the flange. When it is desired to have the tripping of the tap controlled by the work, the tap is furnished with a plate trip. The tap is simple in operation and construction, as it consists of only five units. All parts subject to wear are hardened and ground, and adjustments are conveniently made.

BILTON NEW-TIP HAMMER

The reconditioning of lead hammers that have become battered from use is a considerable bother in the average shop. With a view to eliminating this trouble and permitting a more economical use of hammers of this type, the Bilton Machine Tool Co., Bridgeport, Conn., is now making a hammer consisting of two renewable tips, a semi-steel handle, and a cap and screws for locking the tips to the handle. These tips may be made from lead, copper, brass, fiber, rawhide, or any special metal. The accompanying illustration shows one of these hammers assembled, and also an extra tip.

The shouldered shank of the tip is simply seated in recesses machined in the handle and cap to suit, and then locked in place by tightening the screws. With this design a supply of tips may be conveniently kept in a tool-crib and the hammer refitted as the tips become worn. The hammer is made in three sizes, the length from the center of the tips to the end of the handle, the distance between the faces of the tips, and the diameter of the tips, varying with each size. The intermediate size weighs 4½ pounds.

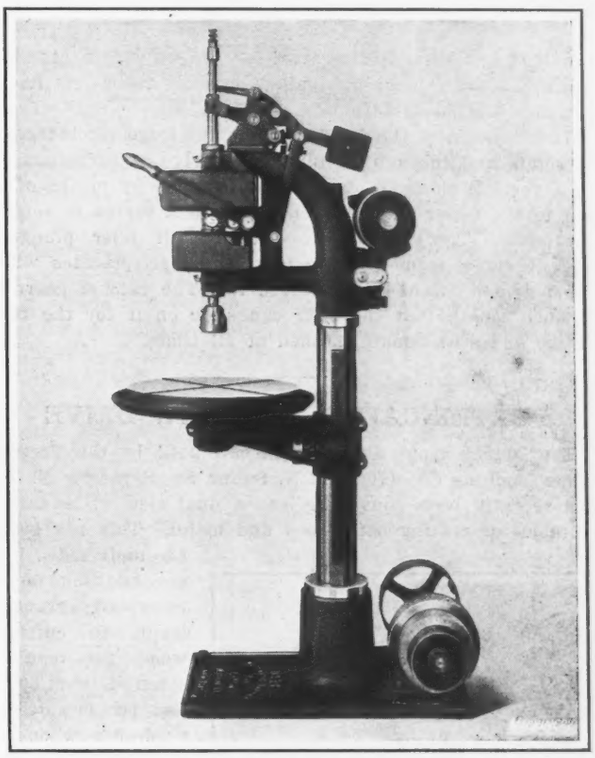


Bilton Hammer with Renewable Tips

GARVIN AUTOMATIC TAPPING MACHINE

Several improvements have been made in the automatic tapping machine built by the Garvin Machine Co., Spring and Varick Sts., New York City. In the previous design the pulleys on the spindle had an extended hub which was assembled into the boxes of the column. This hub formed not only the support for the pulley but also the bearing for the spindle. Thus both the spindle and its bearing revolved, and, as a consequence, a tight belt could cause the spindle to cock or result in excessive wear on the spindle-box.

In the new design the pulleys do not have an extended hub, but instead are mounted on taper roller bearings which take up both radial and thrust loads, the bearings, in turn, being mounted on a bronze sleeve which is screwed into threads in the column box and thus held stationary. With this construction the pull is in direct line with the center of the bearing and is not transmitted to the spindle. There is also an additional support for the pulleys, as well as the elimination of the possibility of cocking. As the bearing

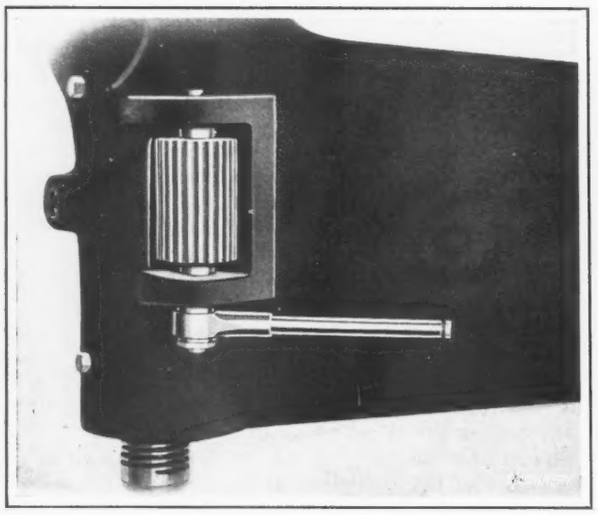


Garvin Improved Automatic Tapping Machine

for the spindle is stationary, a double belt can be used for heavy work. The idler pulleys and back-shafts are also mounted in taper roller bearings. Improvements in the table include deep oil channels and a large drain into oil reservoirs.

HANNA DIE-SCREW ADJUSTMENT

A die-screw adjustment has recently been developed as an accessory to the pneumatic riveting machine built by the Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill. This adjustment allows of employing the riveting machine on plates of varied thicknesses, with little loss of time in adjusting the dies for each new grip. For ordinary variations in thicknesses of plates it is not necessary to readjust the die-screw on the Hanna riveter, as this is provided for by means of a patented mechanism. It is to save time where there are large variations in thickness that the die-screw adjusting device has been developed. A few pulls of the ratchet handle illustrated advances the die-screw the desired amount in a short time. When no such device is



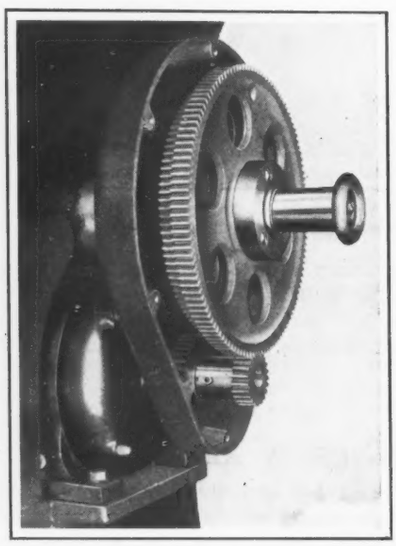
Die-screw Adjustment for Hanna Riveting Machine

provided and the adjustment of the die-screw is necessary, a pair of tongs must be applied, because the screw itself becomes too hot to turn by hand.

The rotation of the handle causes the large ratchet gear to rotate and through an idler gear, drive a gear attached to a vertical shaft. This shaft is fastened by means of a pin to the upper end of the die-screw and serves to rotate the latter. The gear on the vertical shaft, idler, plunger, and die-screw form a single unit which reciprocates with the patented mechanism referred to. The ratchet gear is of such length that the idler can slide on it for the full stroke and still remain meshed at all times.

PORTER-CABLE BAND-SAW DRIVE

The 20-inch motor-driven band saw built by the Porter-Cable Machine Co., 1708-1712 N. Salina St., Syracuse, N. Y., has recently been converted into a dual type of machine suitable for cutting both wood and metal. This has been accomplished by the addition of a two-speed arrangement. In cutting wood, the regular speed of about 3000 feet per minute is used, but when it is desired to cut metal, the knob of the gear-case illustrated is pulled out so as to shift the gears and reduce the speed of the saw about one-half. The motor is totally enclosed in the base, and the whole driving mechanism runs in oil. It is equipped with ball bearings throughout. The new arrangement makes the machine suitable for cutting aluminum and brass and sawing scroll designs in hard rubber and fiber.

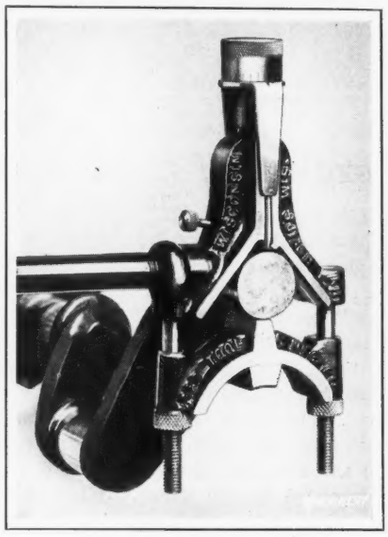


Porter-Cable Two-speed Band-saw Drive

KRIEGER RE-TURNING TOOL

A tool intended for re-turning such parts as worn or scarred automobile crankpins and shafts is now made by the Krieger Tool & Mfg. Co., Wisconsin Rapids, Wis. It can be applied to a crankshaft in the engine, or in a lathe or vise. From the illustration it will be seen that the device consists essentially of a part that holds the tool, and a second member that bears on the part being turned at a point diametrically opposite the cutter. This second part is attached to the first by means of two studs and nuts. The tool can be adjusted by means of a micrometer screw. When fastened as shown, the clamp is set for fitting small-diameter work, but larger work can be accommodated by simply reversing the clamp on the studs. The vee of the part in which the cutter is held guides the tool so as to finish the part round.

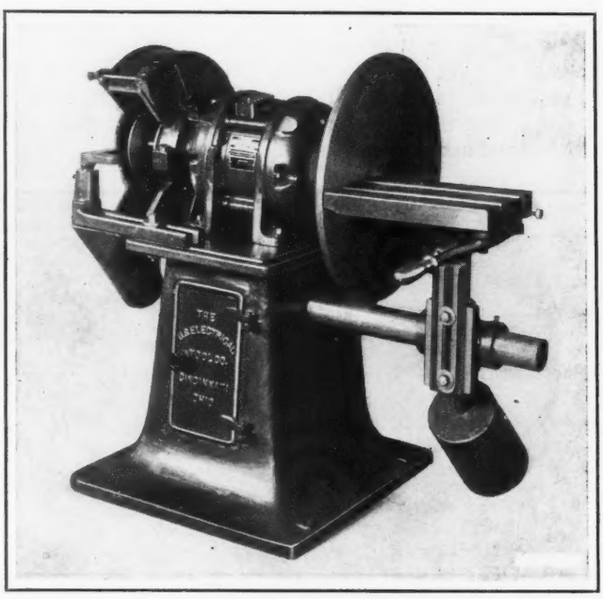
When the tool has been clamped in place, it is revolved by means of the handle, the micrometer screw being turned to advance the tool at each revolution until the part has been finished. The capacity of this device is for work from 1⅛ to 2¾ inches in diameter. As an illustration of the adaptability of the device for a wide range of work, it is mentioned that, besides its use for re-turning crankpins, it has also been employed for roughing and finish-turning a 2¼-inch double-thickness pipe 20 feet long, for the entire length.



Krieger Re-turning Tool for Such Parts as Automobile Crankshafts

U. S. COMBINATION EMERY WHEEL AND DISK GRINDER

A 5-horsepower combination emery wheel and disk grinder equipped with ball bearings is being placed on the market by the United States Electrical Tool Co., Cincinnati, Ohio. The disk is 24 inches in diameter. Among other features, this machine is provided with an automatic push-button control, a shaft-locking device, and a hinged exhaust-connection wheel guard.



U. S. Combination Emery Wheel and Disk Grinder

BILTON DIE-HOLDERS

A complete line of die-holders for punch presses is now manufactured by the Bilton Machine Tool Co., Bridgeport, Conn. These holders are made in various styles with two or four pins, and there is also a sub-press type. Two holders of typical design are illustrated in Figs. 1 and 2. The standard types and sizes cover a large portion of punch-press work, but special sets are also made for jobs where a standard set is not suitable. The holders are semi-steel castings, and the liner pins are made from either tool or machine steel, hardened and ground. The standard types are furnished without bushings in the punch-holder, because of the holder being semi-steel and moving vertically on hardened pins; however, bushings can be provided when desired. The bottom die-block of all designs is cast with a rib to afford a method of fastening to the bolster-plate, and on the heavier

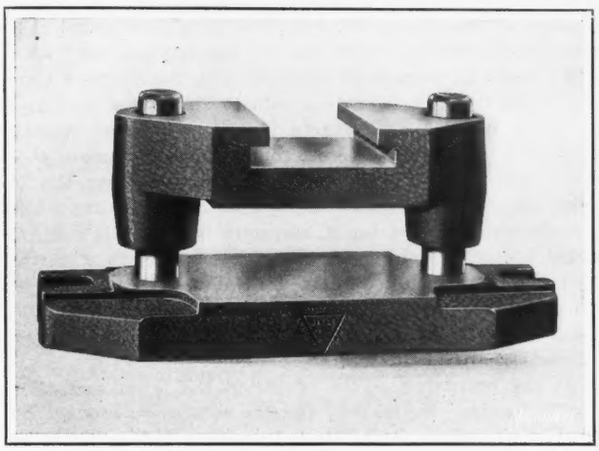


Fig. 1. Bilton Die-holder of the Two-pin Type

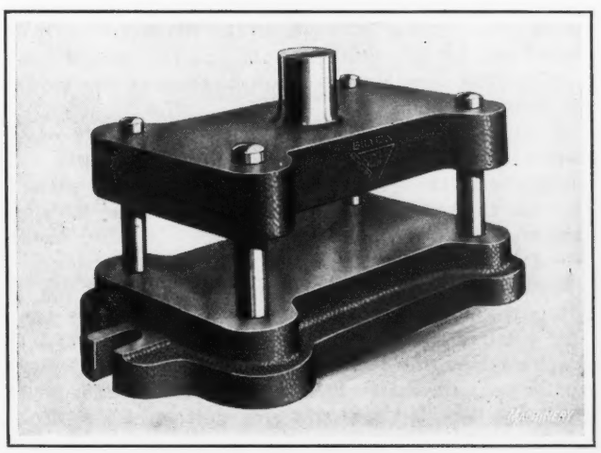


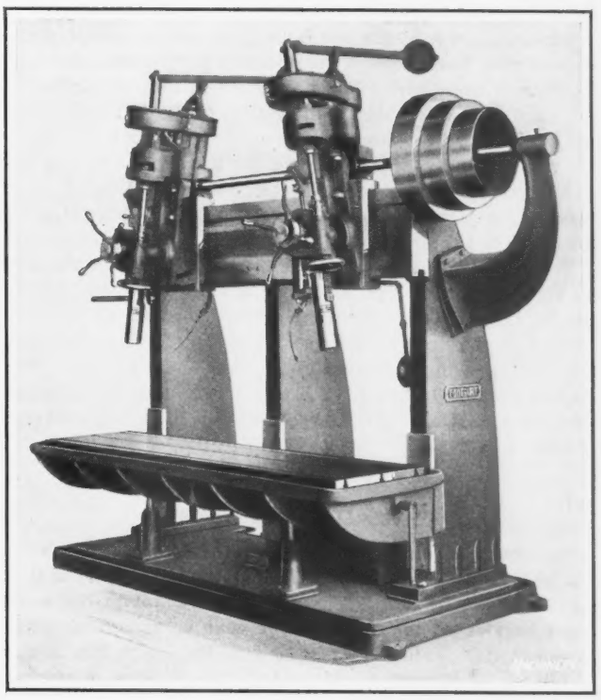
Fig. 2. Typical Four-pin Die-holder

designs, T-slots or lugs are provided in addition to the rib. A line of pry bars is also made for use in connection with these die holders.

FOOTE-BURT AXLE DRILLING MACHINE

The king bolt holes on automobiles equipped with four-wheel brakes, are drilled at an angle in the front axle, the angle varying with different types of cars. A machine universally adapted to the performance of this operation on various axles has been produced by the Foote-Burt Co., Cleveland, Ohio. Its design was worked out by incorporating the standard heads of Foote-Burt high-duty drilling machines with the uprights, cross-arm, and table of the rail-type machine built by the same company.

To provide for drilling the holes at the angle specified, the heads are carried on saddles equipped with a swivel



Foote-Burt Equipment for drilling King Bolt Holes at Angles in Automobile Axles

arrangement which enables each spindle to be inclined at any angle up to 15 degrees either side of the center. There is a double feed rack on the spindle sleeve which equalizes the thrust incident to drilling. Four changes of feed and, without back-gears, three speed changes are provided. Back-gears can be furnished as special equipment to increase the range of speed changes. As illustrated, the machine is furnished with a right-hand drive, but a left-hand drive is considered standard.

ROCKWELL FORGE

A new forge known as the "Economizer" is a recent addition to the line of industrial heating equipment made by the W. S. Rockwell Co., 50 Church St., New York City. Its

Rockwell Forge of New Design

design is said to permit the furnace to be placed close to a machine. Low-pressure air is used in one system of piping to maintain heat, protect the operator from gases, and blow scale from the dies. This is accomplished by supplying the air in a downward blast which deflects the hot gases from the operator and against a preheater, inducing a current of air past the operator and toward the furnace. The deflected gases pass through the preheater, which is located in an insulated outlet chamber, and are finally discharged above the head of the operator.

All air delivered to the forge is controlled by a threaded air-tight blast gate equipped with a brass slide, and the air passes through the preheater. This permits an accurate control of the fire and the atmosphere in the heating chamber, and prolongs the cooling. The forge is lined with double courses of brick to break joints and decrease loss through radiation. The forge is built in a large variety of sizes and types.

* * *

VANADIUM IN STEEL

Vanadium is one of the most useful of the rare metals. The chief deposits of vanadium and the most important in the world are in Peru. The Peruvian vanadium ore sometimes carries as much as 50 per cent of vanadium oxide. In the United States the largest deposits are in San Miguel County in southwestern Colorado. The average ore mined there has a content of from 1 to 2 per cent vanadium oxide. Vanadium is used chiefly in steel for purposes requiring great toughness and torsional strength, common applications being in automobile parts, gears, piston-rods, tubes, boiler plates, transmission shafts, gun barrels, and forgings that have to withstand great stresses and wear. The vanadium content in steel usually ranges from 0.1 to 0.4 per cent. Vanadium is also used occasionally in certain tungsten alloy steels for making high-speed steel. Introduced in small proportions, it reduces considerably the amount of tungsten required in steel for a given hardness and toughness. Vanadium differs from tungsten in that it has a good effect not only on tool steel, but on structural steel as well.

Chrome-vanadium steels and chrome-vanadium-molybdenum steels are the latest developments in structural alloy steels that have gained an extensive market. Almost all these steels are made in the open-hearth furnace, chromium and vanadium alloys being added shortly before casting. In their physical properties these steels are much like chrome-nickel steels, but they have a greater contraction of area. Most of the chromium-vanadium steels made go into automobiles. Some manufacturers prefer them because of their greater freedom from the surface imperfections—notably seams—which the steels containing nickel are likely to have.

* * *

A two-weeks course in industrial organization and management, extending from June 16 to 28, inclusive, is being offered by the Pennsylvania State College. The course will be given under the supervision of the Department of Industrial Engineering. This will be the ninth season that this course has been given at the college. The subjects to be discussed include organization and administration; the industrial plant; purchasing and stores; manufacturing methods; planning and production control; industrial accounting; and personnel administration. Further information can be obtained from the Industrial Engineering Department of the Pennsylvania State College, State College, Pa.

* * *

The position that women are beginning to take in engineering in Great Britain is indicated by the fact that the second International Conference of Woman Engineers was held in Manchester during April. British, American, and Belgian women were present and read papers, and visits were made to local engineering works and textile mills.

CYLINDER HONING

Honing as a process for finishing cylinder bores has come into extensive use among automobile and engine builders, and several of the leading companies that are at present finish-grinding their cylinders are known to be studying the possibilities of the newer process. Some uncertainty as to the distinction between honing and lapping seems to exist among engineers, but in general the former term is correctly applied to the use of stones as abrasives, while the latter is understood to involve the use of a lap or carrier charged with an abrasive. Precision of dimensions, closeness of fit, and the polishing of the surfaces may be considered the objectives of both processes.

A recent survey of cylinder-finishing methods made by the research department of the Society of Automotive Engineers, as published in the society's *Journal*, included twenty-four of the well-known builders of automobiles and engines. Twelve of these hone the cylinders, nine finish-grind them, while the remaining three use the lapping process.

At least one prominent company uses honing as a sizing and corrective operation to eliminate any of the high spots or other undesirable features that remain after reaming. The cylinders are first bored, then reamed to remove about 0.010 inch of metal, and finally honed to remove the last 0.001 inch. Tolerances of 0.0005 and 0.001 inch are set for out-of-roundness and taper, respectively. In this case, the bores are at present being honed separately in a vertical single-spindle machine; but a multiple-spindle machine better adapted to production work is being built. The abrasive stones are held rigidly in the rotating tool during the period of vertical travel through the cylinder.

At the beginning of the operation the lower end of the tool is inserted in the bore and the stones are brought into contact with the cylinder walls by an expansion device. The tool is next fastened to the driving spindle of the machine through a coupling. Then it is fed through the cylinder at a reasonably slow rate while being rotated rapidly. Upon reaching the bottom of the bore, the stones are again expanded into contact with the walls and the upward stroke is made. The work is flooded with kerosene as a lubricating and cooling medium.

In contrast with the example cited, a majority of the shops depend entirely upon the reaming and grinding operations to give them sufficiently perfect cylindrical surfaces. They use the hone only as a means for removing the slight roughness or "fuzz" and to give a highly polished surface. In such cases the honing stones, usually three or four, are held against the work by springs inside the tool.

It is the practice in certain shops to give to the tool a rapid rotative motion and a slow travel along the cylinder axis; in others, the tool is rotated very slowly and moved rapidly along the axis; while in still others it is not rotated within the bore, but only at the completion of each stroke, and then by small but unequal steps of a few degrees each.

The practice at the Lincoln plant may be taken as an example of the method last mentioned. Here it is believed that the pistons of an automobile engine should not be required to finish and polish the cylinder walls when the honing method of finishing makes possible the production of a better running engine and the elimination of the "breaking-in" process often specified for new cars. Before being honed the cylinders are bored in three steps, then ground in eight or ten steps, with cooling and seasoning periods of four or five hours between grindings. To obtain the final finish, the cylinder block is set in the honing machine, and the tools take up a reciprocating motion without rotation within the bores. The hones are rotated or indexed, however, by unequal steps at the end of each stroke. The carborundum stones are held against the work by springs within the tool. This honing operation produces a mirror-like finish, but is not used as a sizing or corrective measure; an extremely small amount of metal is removed from the walls. Kerosene is used as a lubricating and cooling medium.

PERSONALS

F. W. McINTYRE has been elected vice-president of the Reed-Prentice Co., Worcester, Mass. Mr. McIntyre will also continue to fill his duties as sales manager.

FRED J. MERSHON, for many years export sales manager of the Industrial Works at Bay City, Mich., has been placed in entire charge of the Detroit branch office of the company located in the Book Bldg.

L. A. MARSHALL, for many years service manager of the Industrial Works, Bay City, Mich., is now connected with the Chicago office of the company at 1051 McCormick Building in the capacity of sales engineer.

JOHN HOWE HALL, metallurgist with the Taylor-Wharton Co., has been awarded the J. H. Whiting medal of the American Foundrymen's Association in recognition of his contributions to the steel casting industry.

WILLIAM R. WALLIS, for twelve years a representative of the *American Machinist*, has been appointed special representative of the *American Exporter*, 370 Seventh Ave., New York City, with headquarters in New York.

HOWARD U. HERRICK has been elected vice-president and general manager of the V & O Press Co., Hudson, N. Y. For the last five years Mr. Herrick has been factory manager of the Brown Lipe Gear Co., of Syracuse, N. Y.

BLAKE D. HAY, district manager of the Chicago branch of the Williams Tool Corporation, 549 W. Washington Blvd., has resigned. He will be succeeded by DAVID MAXWELL who has been the district manager at Cleveland, Ohio, for some time.

ENRIQUE TOUCEDA, professor of metallurgy at the Rensselaer Polytechnic Institute, has been awarded the John A. Penton medal of the American Foundrymen's Association in recognition of the contributions he has made to the malleable casting industry.

E. W. ALLEN, formerly engineer and assistant manager of the Central District of the General Electric Co., with headquarters in Chicago, has been appointed manager of the engineering department. A. F. RIGGS has been named district engineer to succeed Mr. Allen.

AUSTIN M. MUELLER, general manager of sales of Joseph T. Ryerson & Son, Inc., 16th and Rockwell Sts., Chicago, Ill., was the guest of honor at a dinner tendered to him by his associates to commemorate the completion, on April 26, of twenty-five years of service with the company.

W. C. DAVIS, for twenty-three years connected with the Davis-Watkins Dairyman's Mfg. Co., the last seven of which he was president of the company, is now connected with the Foote Bros. Gear & Machine Co., 210-220 N. Carpenter St., Chicago, Ill., in the capacity of vice-president and general manager.

CHARLES A. COFFIN, formerly president of the General Electric Co., Schenectady, N. Y., was awarded a certificate of honorary membership in the Franklin Institute in April at Philadelphia. This honor was in recognition of Mr. Coffin's many achievements and contributions to the electrical industry.

IRA D. GROVE, formerly sales representative for the Landis Tool Co. in the Cleveland and Detroit territory, has been appointed sales manager of the Lees-Bradner Co., Cleveland, Ohio, to succeed GLEN MUFFLY, who is opening an office in Chicago as consultant on the merchandising of automotive and mechanical products.

CLIFTON REEVES, who for the last five years has been industrial engineer for the Willys-Overland Co., at Toledo, Ohio, has opened offices at 149 Broadway, New York City, where he will engage in general industrial engineering practice, including the preparation of surveys through analytical investigation as a basis for financing.

S. H. MARCH has joined the staff of Alfred Herbert, Ltd., Coventry, England, to assist in the development of the company's business. Mr. March was formerly director and general manager of the Churchill Machine Tool Co., Ltd., of Broadheath, near Manchester, and also for many years manager for Charles Churchill & Co. in Lancashire and Yorkshire.

AMBROSE SWASEY, of the Warner & Swasey Co., Cleveland, Ohio, past president of the American Society of Mechanical Engineers, has been awarded the John Fritz medal for his "achievement as a designer and manufacturer of instruments and machines of precision, a builder of great telescopes, a benefactor of education, and as the founder of the Engineering Foundation."

CARL LINDEN, sales engineer for the Cincinnati Planer Co., and the Acme Machine Tool Co., of Cincinnati, has been appointed eastern sales manager for these companies, and will be located permanently in New York City. Mr. Linden will look after the sales of these two companies in connection with their regular agents, Henry Prentiss & Co. of New York, and W. E. Shipley Machinery Co. of Philadelphia.

GEORGE C. MCMULLEN, formerly manager of sales of the Industrial Bearings Division of the Timken Roller Bearing Co., Canton, Ohio, has been made district manager of sales of the Timken interests on the Pacific Coast, with headquarters at San Francisco, Cal. HARRY H. GILDNER, formerly in charge of the Chicago office of the company, has been made manager of the Industrial Division, with headquarters at Canton.

PAUL C. DEWOLF, assistant treasurer of the Brown & Sharpe Mfg. Co., Providence, R. I., was elected president of the National Metal Trades Association at its last annual convention. Mr. DeWolf is a graduate of Brown University, and has been connected with the Brown & Sharpe Mfg. Co. for a number of years. He has been active in the work of the National Metal Trades Association, being counselor in 1920 and 1921, and second vice-president in 1922, which latter office he has held for the last two years. Mr. DeWolf is also a member of the American Society of Mechanical Engineers.

OBITUARY

FRANK C. CALDWELL, a director of the Link-Belt Co. since the purchase of the H. W. Caldwell & Son Co., by the Link-Belt Co. in 1921, was stricken with heart failure on the morning of May 15 while on his way to his bank. He died in an ambulance en route to a hospital. Mr. Caldwell was born in Indianapolis in 1866, and went to Chicago in the early eighties to complete his education at the Union College of Law. He practiced law until 1892, when he became vice-president of the H. W. Caldwell & Son Co. In 1908 he became president, which position he held until the company was purchased by the Link-Belt Co. in 1921. Since then he has been a director of the Link-Belt Co. Mr. Caldwell was president of the National Metal Trades Association from 1911 to 1912, and served as its treasurer from 1912 to 1922.

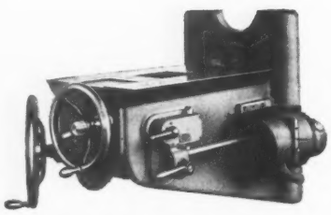
CREDIT FOR SPARK TESTING DEVELOPMENTS

We have been informed by Stanley P. Rockwell, metallurgical engineer of Hartford, Conn., that the developments in the use of the spark testing method for carbon determination in steel, described by Mr. Rockwell in an article in June, 1923, MACHINERY, should be credited to D. H. Stacks. In the article mentioned, credit for the development of the method was given to two people, but investigation shows, Mr. Rockwell says, that this development was due entirely to D. H. Stacks.

* * *

"The greatest need of American education is simplification," says Dr. Thomas S. Baker, president of Carnegie Institute of Technology. "We are continually looking for a system of education that will meet the needs of the times. We shall never find one. We are giving too much importance to methods and not enough to substance; too much importance to courses of study and not enough to the individual teacher. College and school executives are so enmeshed in a maze of administrative details that they are in danger of building up systems rather than strengthening faculties. Too many courses are being given both in the schools and the colleges. We are sacrificing thoroughness as we extend our program of work. The public is expecting of the colleges training in too many kinds of vocations. Even in the technical schools we could well afford to throw overboard some of our specialties, and focus our efforts upon teaching more thoroughly the subjects that are essential in the training of an engineer. It is futile to expect to turn out an accomplished engineer in four years. We can only hope to give him the foundation, and the changing technique of his profession must be learned through practical work."

A sturdy knee supports heavy work and deep cuts



In finding the line between sufficient strength and excessive weight, experience is oftentimes the best guide. There are 90 years of experience behind every Brown & Sharpe Product. The long test of actual use has shown us how to secure strength and handiness in every product bearing our name.

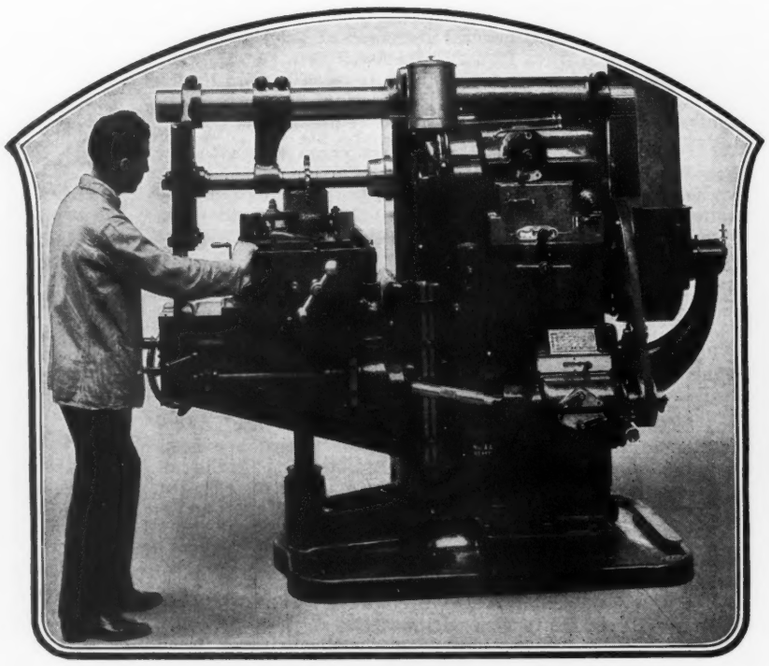
The ruggedness and accuracy of Brown & Sharpe Plain, Universal and Vertical Milling Machines fit them for either heavy or light Milling. They are all highly developed machines adaptable to many kinds of work. Each part of their construction is well proportioned giving strength for heavy work, accuracy and practically eliminating vibration.

Take the knee for instance—it is well braced and husky—capable of supporting heavy work and preventing vibration on deep cuts. It has a long bearing on the column extending well above the top of the knee. The knee is clamped firmly to the column from the front of the machine thereby saving many footsteps.

The column, saddle and table are all equally well constructed forming a sturdy reliable machine.

Consider the economy of adding such a machine to your shop. It has the ability to produce accurate work at a rapid rate.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.



Brown & Sharpe Milling Machines are made in five styles and over 30 sizes—a style and size for every requirement. The entire line is listed in our No. 137 Catalog. Write for your copy today.

BROWN &

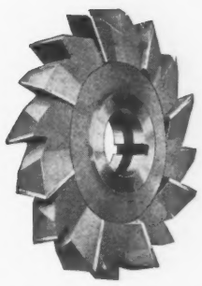
For milling deep slots use Staggered-tooth Cutters

Because of the alternate right and left-hand spiral angles of the teeth, Brown & Sharpe Staggered-Tooth Cutters can remove a large amount of metal without destructive vibration and chatter, making deep cuts with a good finish.

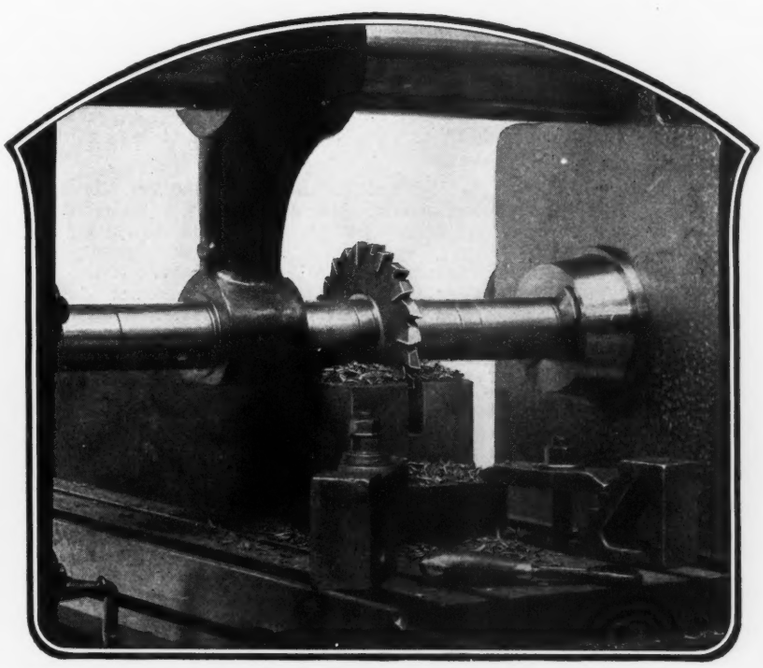
They are especially effective in milling deep slots. They cut through the metal with great ease and are capable of working up to the hub in a single cut when necessary.

The cutting away of the drag side of every tooth prevents rubbing, lessens friction and keeps the cutters cool; and a cool cutter does more work between resharpenings. Use Brown & Sharpe Staggered-Tooth Cutters for deep slotting. Their effectiveness will be more than satisfactory.

BROWN & SHARPE MFG. CO.
Providence, R. I., U. S. A.



In addition to slotting, Staggered-Tooth Cutters have proved extremely efficient for cutting deep shoulders or for straddle milling where two or more slots or shoulders must be cut. In gang milling, when a deep slot or shoulder forms part of the contour, the smooth cutting action of these Staggered-Tooth Cutters speeds up production.



SHARPE

Are your tool-rooms fully equipped? Don't say "Yes" until you've seen our Small Tool Catalog and compared your equipment with the 2000 tools described in its pages. If your dealer hasn't a copy write to us direct.

TRADE NOTES

VANADIUM ALLOYS STEEL CO., Latrobe, Pa., has removed its New York office to 270 Madison Ave.

CONSOLIDATED TOOL WORKS, INC., 296 Broadway, New York City, are now represented in New England by the Bolton Co., 261 Franklin St., Boston, Mass.

WAGNER ELECTRIC CORPORATION, St. Louis, Mo., announces that its Pittsburg representative, Ludwig Hommel & Co., moved to 929 Penn Ave., Pittsburg, Pa., on May 31.

AMERICAN HOLLOW BORING CO., Erie, Pa., has bought additional land and enlarged its shop, so as to provide 25 per cent more manufacturing space as well as room for a new office.

COLUMBIA TOOL STEEL CO., Chicago Heights, Ill., has now completed and in operation a new electric annealing installation. All the tool steel produced by this company is now being treated by this method.

NORTHERN MACHINERY CO., 5th Ave., S., and Sixth St., Minneapolis, Minn., dealer in wood- and iron-working machinery and supplies, has moved the Duluth office of the company to Room 709, Providence Bldg.

EASTERN CUTTER SALVAGE CORPORATION, Newark, N. J., is moving on June 1 from 13 Kirk Place to 37 Freeman St. The company is doubling its present equipment, so that it will be in a position to give more prompt deliveries.

LELAND-GIFFORD CO., Worcester, Mass., has opened a direct selling office at 5905 Carnegie Ave., Cleveland, Ohio, to take care of the Cleveland district, which comprises the state of Ohio. A. H. Anderson is in charge of the new office.

CONNECTICUT BELTING CO., 95 Chestnut St., Norwich, Conn., has been organized to manufacture oak-tanned leather belting. The officers are Ernest L. Baldwin, president; Francis H. Stager, vice-president; and Stanley M. Kingsbury, secretary and treasurer.

MAX AMS MACHINE CO., 101 Park Ave., New York City, manufacturer of automatic machinery for cans and metal containers, has transferred its Chicago office to larger quarters in the Straus Building, 310 S. Michigan Boulevard. M. D. Hopkins is western manager.

OILGEAR CO., 398 Thirty-eighth St., Milwaukee, Wis., manufacturer of variable-speed hydraulic power transmissions, broaching machines, presses, riveters, etc., has appointed the Marshall & Huschart Machinery Co., 17 S. Jefferson St., Chicago, Ill., its agent in the Chicago territory.

CROCKER-WHEELER CO., Ampere, N. J., at its last annual meeting re-elected the following officers: President, Edmund Lang; vice-president, Arthur L. Doremus; secretary, Herbert C. Petty; treasurer, Theodore S. Fuller; assistant secretary and assistant treasurer, George W. Bower.

CLEVELAND STONE CO., Cleveland, Ohio, which some time ago acquired the Sterling Grinding Wheel Co., and has since been making improvements in the plant and products, announces the development of a new wheel intended especially for grinding aluminum. This wheel is called "Luminite."

FIRTH-STERLING STEEL CO., McKeesport, Pa., at the annual meeting of the stockholders in April elected the following directors: Lewis J. Firth, president; Eben B. Clarke, vice-president; D. E. Jackman, treasurer; L. Gerald Firth and Thomas D. McCloskey. E. D. Gray was elected secretary of the company.

DANUBE SOCIETE POUR LE COMMERCE ET L'INDUSTRIE, 77 Boulevard Maria Louisa, Sofia, Bulgaria, announces that this company wishes to secure agencies for American machine tools and machinery in general that would be likely to find a market in Bulgaria, and invites correspondence from interested manufacturers.

BUFFALO FORGE CO., 144 Mortimer St., Buffalo, N. Y., announces the opening, on June 1, of a new western office at Seattle, Wash. The territory of this office will include Oregon, Idaho, Montana, Washington, and Alaska. Arthur T. Forsyth of the Buffalo plant will be western representative in charge.

UNION CARBIDE CO., 30 E. 42nd St., New York City, advises that the suit brought against the Union Carbide and Carbon Corporation and the Davis-Bournonville Co., for alleged conspiracy to violate anti-trust laws has been dismissed in the United States District Court of Maryland, because of a complete lack of proofs to substantiate the charges.

GEOMETRIC TOOL CO., New Haven, Conn., has appointed the Aumen Machinery Co., 107 E. Lombard St., Baltimore, Md., its exclusive representative for Maryland, District of Columbia, Virginia, and eastern West Virginia. A stock of the company's standard threading tools and chasers will be carried by the Aumen Machinery Co. for the convenience of customers.

CRESCENT MACHINE CO., 56 Main St., Leetonia, Ohio, manufacturer of woodworking machinery, announces that a reversible single-spindle shaper, self-contained with ball-bearings, has been added to the Crescent line of woodworking machinery. In this machine are embodied features of construction that will make it especially suitable for use where constant and accurate production is demanded.

K. & S. TOOL & MFG. CO. has been organized at E. Walnut St., Elyria, Ohio, to engage in die work and the building of special machinery and machine tools, as well as machine contract work. The officers of the company are as follows: President and general manager, George R. Kunkle; and secretary-treasurer, H. J. Schulz. Mr. Kunkle served as chief engineer for the General Phonograph Co. for many years.

J. D. WALLACE & CO., Chicago, Ill., manufacturers of woodworking machinery and machine tools, have erected a new factory at 134 S. California Ave. The plant is a one-story building of fireproof construction. All the manufacturing and assembling is done on a specialized progressive system in which each machine moves ahead until completed and ready for shipping, so that all operations are carried out on one floor.

CHAS. A. SCHIEREN CO., 73 Ferry St., New York City, tanner and manufacturer of belting, announces that as a result of a recent suit brought by the company for infringement of their "Duxbak" trademark for belting, the District Court of the United States for the Southern District of Ohio has enjoined the Allied Belting Co. from the use of a trademark similar to the well-known "Duxbak" trademark used by the Schieren Co.

DUELL, WARFIELD & DUELL, which has been engaged in patent law practice for seventeen years, has been dissolved and is succeeded by the firm of Duell, Anderson & Duell, 19 W. 44th St., New York City. The following men, who were associated with the predecessor, will remain with the new firm: Holland S. Duell, James W. Anderson, W. H. Crichton Clarke, David A. Woodcock, Willis B. Rice, Carl W. Weeks, and J. E. Daniels.

AMERICAN BRONZE CORPORATION, Berwyn, Pa., manufacturer of "Non-Gran" bronze, announces that the receivership under which the corporation has been operated since August, 1923, has been terminated, the business now having been restored to the stockholders, and that all creditors will receive 100 cents on the dollar. The officers of the corporation are: E. G. Anderson, president; William F. Fischer, vice-president; G. Willard Frame, treasurer; and John C. Smith, secretary.

OILGEAR CO., 398 Thirty-eighth St., Milwaukee, Wis., manufacturer of variable-speed hydraulic power transmissions, hydraulic broaching machines, presses, riveters, etc., has appointed Henry Prentiss & Co. its exclusive agent in the New England states, New York state, northern New Jersey, and northeastern Pennsylvania. The main office of Henry Prentiss & Co. is located at 149 Broadway, New York City, and branch offices are maintained in Boston, Buffalo, Hartford, Rochester, and Syracuse.

BRISTOL CO., Waterbury, Conn., manufacturer of recording instruments and distributor of radio equipment, has leased 2740 square feet in the Larkin Building, 3617 S. Ashland Ave., Chicago, Ill., in order adequately to take care of the Middle West business, which has grown to large volume. Most of this area will be devoted to repairing and recalibrating Bristol instruments sold and used in the Chicago territory, but some will be used for stocking made-up instruments for quick deliveries and various lines of radio merchandise. The present salesroom and offices of the Bristol Co. will be maintained in the Monadnock Building.

MEACHEM GEAR CORPORATION, Canal St., and West Shore R. R., Syracuse, N. Y., has taken over the plant of the WEEKES-HOFFMAN CORPORATION at 122-142 Dickerson St., Syracuse, and will now enter the automobile gear field, producing, for the present, service gears for automobile repairs. The officers of the Meachem Gear Corporation are: T. G. Meachem, president; J. F. S. Meachem, vice-president and treasurer; and George W. Wood, secretary. T. G. and J. F. S. Meachem, with their father, the late Thomas W. Meachem, were responsible for the organization of the New Process Gear Corporation, which in 1919 was sold to John N. Willys of the Willys-Overland Co., of Toledo, Ohio. The Meachem Gear Corporation was organized later in 1919 to take over from the New Process Gear Corporation the department engaged in the manufacture of New Process rawhide pinions and commercial gears. The present plant at Canal St., Syracuse, of the Meachem Gear Corporation will be removed to the newly acquired plant at Dickerson St.

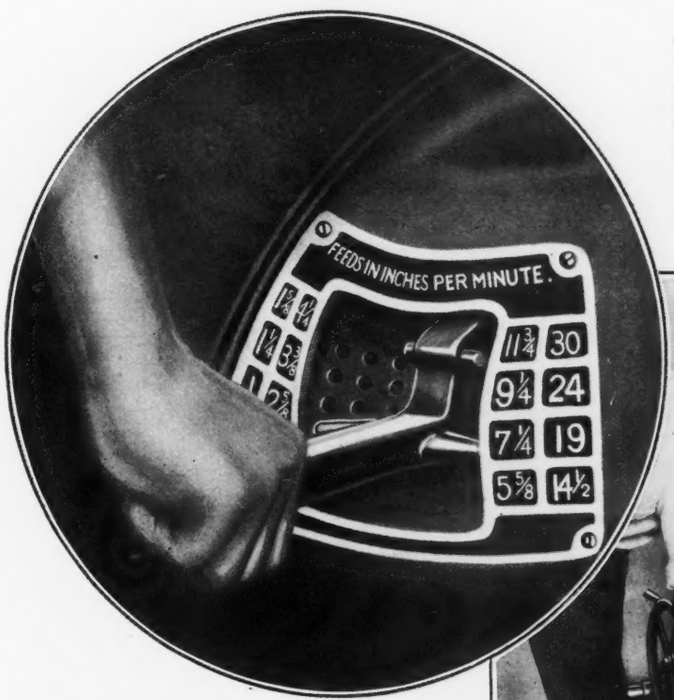
Little Stories of Service and Savings

"A Decided Increase in Production"

AMERICAN CAN COMPANY *says—*

"We recently purchased two No. 4 High Power Cincinnati Milling Machines. In addition to other productive features, they are equipped with the single feed change lever at the front of the knee. This is a decided improvement and is *very handy to operate.*

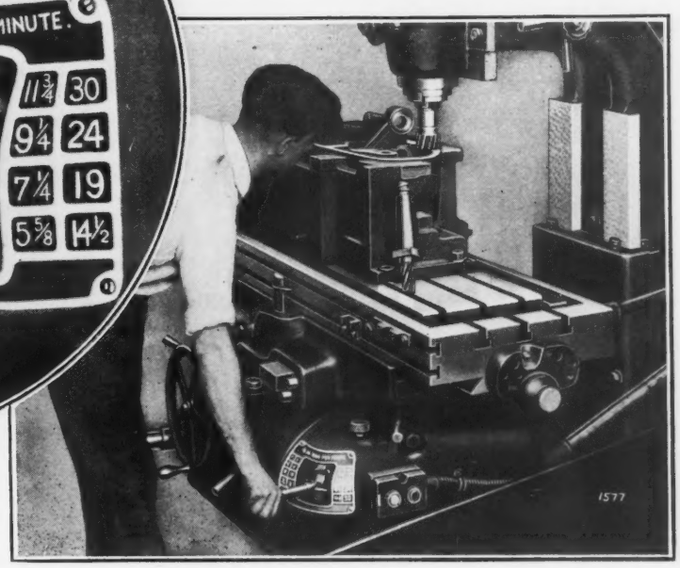
We are very much pleased with these new machines and have noticed *a decided increase in production* since installing them."



The SINGLE Feed Change Lever at the FRONT of the knee
(PATENTED)

This is but one of many patented productive features on Cincinnati No. 4 and No. 5 High Power Millers. Send for the special booklet describing them all.

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO



"One advantage of this single feed change lever, is that the operator does not have to leave his regular position at the front of the machine in order to make feed changes, which saves a considerable amount of time."

CINCINNATI MILLERS

COMING EVENTS

JUNE 4-6—Eleventh annual foreign trade convention in Boston, Mass. O. K. Davis, India House, Hanover Square, New York City, secretary.

JUNE 11-18—Convention and exhibit of Section V Mechanical, of the American Railway Association in Atlantic City, N. J. Secretary, V. R. Hawthorne, 431 S. Dearborn St., Chicago.

JUNE 11-18—Convention and exhibit of the Railway Supply Manufacturers' Association in Atlantic City, N. J. Secretary, J. D. Conway, 1841 Oliver Bldg., Pittsburg, Pa.

JUNE 12-14—Fifth annual conference of the National Association of Office Managers at Niagara Falls on the Canadian side. Secretary, T. G. Woolford, Retail Credit Co., Inc., Atlanta, Ga.

JUNE 23-27—Twenty-seventh annual meeting of the American Society for Testing Materials, in Atlantic City, N. J.; headquarters, Chalfonte-Haddon Hall Hotel. C. L. Warwick, secretary-treasurer, 1315 Spruce St., Philadelphia, Pa.

JUNE 24-27—Summer meeting of the Society of Automotive Engineers at Hotel Monmouth, Spring Lake, N. J. Coker F. Clarkson, secretary, 29 W. 39th St., New York City.

JUNE 30—JULY 12—World power conference in London, England, at the British Empire Exhibition, in cooperation with technical and scientific institutes and industrial organizations. Further information may be obtained from Calvin W. Rice, secretary of the American Society of Mechanical Engineers, 29 W. 39th St., New York City.

SEPTEMBER 15-18—Machine tool exhibit at the Mason Laboratory, Sheffield Scientific School, Yale University, New Haven, Conn., under the auspices of the American Society of Mechanical Engineers, Yale University, and the New Haven Chamber of Commerce. Professor S. W. Dudley is in charge of the exhibit.

SEPTEMBER 22-26—Sixth convention and international steel exposition of the American Society for Steel Treating, in Boston. Secretary, W. H. Eisenman, 4600 Prospect Ave., Cleveland, Ohio.

SEPTEMBER 24-25—Automotive transportation meeting at the Society of Automotive Engineers' headquarters, Engineering Societies' Bldg., 29 W. 39th St., New York City. Coker F. Clarkson, secretary.

OCTOBER 3—Aeronautic meeting of the Society of Automotive Engineers at Dayton, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

OCTOBER 13-18—Twenty-eighth annual convention and exhibit of the American Foundrymen's Association in Milwaukee, Wis. Secretary, C. E. Hoyt, 140 S. Dearborn St., Chicago, Ill.

OCTOBER 22-24—Production meeting of the Society of Automotive Engineers at Detroit, Mich. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

NOVEMBER 18-19—Service engineering meeting of the Society of Automotive Engineers at Cleveland, Ohio. Secretary, Coker F. Clarkson, 29 W. 39th St., New York City.

DECEMBER 1-6—Third National Exposition of Power and Mechanical Engineering in the Grand Central Palace, New York City.

SOCIETIES, SCHOOLS AND COLLEGES

GROVE CITY COLLEGE, Grove City, Pa. Catalogue for 1923-1924, with calendar and courses of study for the year 1924-1925.

UNIVERSITY OF MISSOURI, Rolla, Mo. Bulletin for January, 1924, describing the student life and activities of the School of Mines and Metallurgy.

NEW BOOKS AND PAMPHLETS

OUR AMERICAN SYSTEM OF WEIGHTS AND MEASURES—WHY WE SHOULD KEEP IT. 64 pages, 5 by 8 inches. Issued by the American Institute of Weights and Measures, 115 Broadway, New York City.

This pamphlet sets forth in a non-technical way some of the arguments against the compulsory adoption of the metric system, and makes a protest against a change of standards. Copies will be sent to those interested upon request.

ELIMINATION OF WASTE—FILES AND RASPS. 8 pages, 6 by 9 inches. Published by the Department of Commerce, Washington, D. C., as Simplified Practice Recommendation No. 6 of the Bureau of Standards. Price, 5 cents.

This pamphlet contains the sizes and types of files and rasps adopted as standard at a joint conference of representatives of manufacturers, distributors, and users. By the adoption of these standards, 165 odd sizes and types of files and rasps will be eliminated.

THE STORY OF BAKELITE. By John Kimberly Mumford. 80 pages, 5¼ by 8 inches. Published by the Robert L. Stillson Co., 461 Eighth Ave., New York City. Price, $1.

This little book tells the story of bakelite in an interesting and readable way. Beginning with its origin in the carboniferous deposits of the early geological ages, it is carried through its gradual evolution, finally reaching its present-day widespread application in the radio, automotive, and other industries.

THE MODERN FOREMAN. By Robert Grimshaw. 297 pages, 5¾ by 8½ inches. Published by the Gregg Publishing Co., 285 Fifth Ave., New York City. Price, $2.50.

This book, which is in its second edition, contains a number of shop talks to foremen, given by the author, dealing with the factory manager's duties and problems and the principles upon which successful foremanship is based. The new edition contains an appendix covering points that have come up in the Foremen's Forum, as follows: The Foreman Personally; the Foreman's Job; Leadership; the Foreman and "Labor"; the Workers; Training; Attaining Efficiency; What Production Calls For; Time and Idleness; Knowledge is Power; Morale; Miscellaneous.

MECHANICAL ENGINEERS' HANDBOOK. By Lionel S. Marks. Second edition. 2000 pages, 4½ by 7 inches. Published by the McGraw-Hill Book Co., Inc., 370 Seventh Ave., New York City. Price, $6, net.

The second edition of this well-known handbook has been thoroughly revised and many sections have been rewritten. The book gives practical engineering information supplied by specialists in the different fields that it covers, as well as a complete synopsis of engineering theory. The fifteen sections that it contains deal with the following subjects: Mathematical tables; weights and measures; mathematics; mechanics of rigid bodies; stresses in framed structures; friction; hydraulics; heat; strength of materials; materials of engineering; machine elements; power generation; hoisting and conveying; automobiles; railway engineering; marine engineering; aeronautics; building construction and equipment; machine shop practice; pumps and compressors; electrical engineering; measuring instruments; surveying; mechanical refrigeration; and A. S. M. E. power test codes.

CRAIN'S MARKET DATA BOOK AND DIRECTORY OF CLASS, TRADE, AND TECHNICAL PUBLICATIONS. 505 pages, 6 by 9 inches. Published by G. D. Crain, Jr., 537 S. Dearborn St., Chicago, Ill. Price, $5.

This directory, which covers the class, trade, and technical publications in the United States and Canada, is now in its fourth edition. A number of changes and improvements have been made in the book, based upon the widening demands of subscribers. For the benefit of those who have not seen the previous editions, it may be mentioned that this book gives information relating to markets and general conditions in practically all industries in the United States, as well as a list of the publications which serve these various industries, for the use of the advertiser and the merchandiser. Complete information relating to the publications, such as subscription price, date of publication, page size, advertising rates, circulation, etc., are included. The material regarding publications is even more complete in the new edition than heretofore. In connection with circulation, the distribution by classes of readers is also shown, thus giving the advertiser a better basis for measuring the character of publications. The market data for each section has been revised and in most cases completely rewritten, new figures and other statistical and marketing facts having been included. This data is necessarily of a general character, and is intended merely to supply the basis for research work from which a more intensive study of special factors may be developed. The Canadian and foreign publications are grouped together in a separate section of the book.

NEW CATALOGUES AND CIRCULARS

WHITING CORPORATION, Harvey, Ill. Folder N-1428, descriptive of Whiting cupola-charging machines for foundries.

PHILIP CAREY CO., Cincinnati, Ohio. Bulletin 102, dealing with heat losses, and heat conservation by the use of heat insulating materials.

ALLEN-BRADLEY CO., Milwaukee, Wis. Bulletins 600, 640, 720 and 740, illustrating and describing Allen-Bradley alternating-current resistance starters.

WHITMAN & BARNES MFG. CO., Akron, Ohio. Circular describing the use of W. & B. twist drills and reamers in the manufacture of White automobile trucks.

LEWIS-SHEPARD PLATFORM CORPORATION, 563 E. First St., Boston 27, Mass. Leaflet descriptive of Lewis-Shepard "Lift Truck" platforms with pressed-steel legs.

MOREY & CO., INC., Broome and Lafayette Sts., New York City. Catalogue M-424, containing a complete list of the new and used machine tools that this company has in stock.

NORTHERN BLOWER CO., W. 65th St., south of Denison, Cleveland, Ohio. Bulletin F 1002, containing general data covering the line of "Norblo" exhaust fans made by this concern.

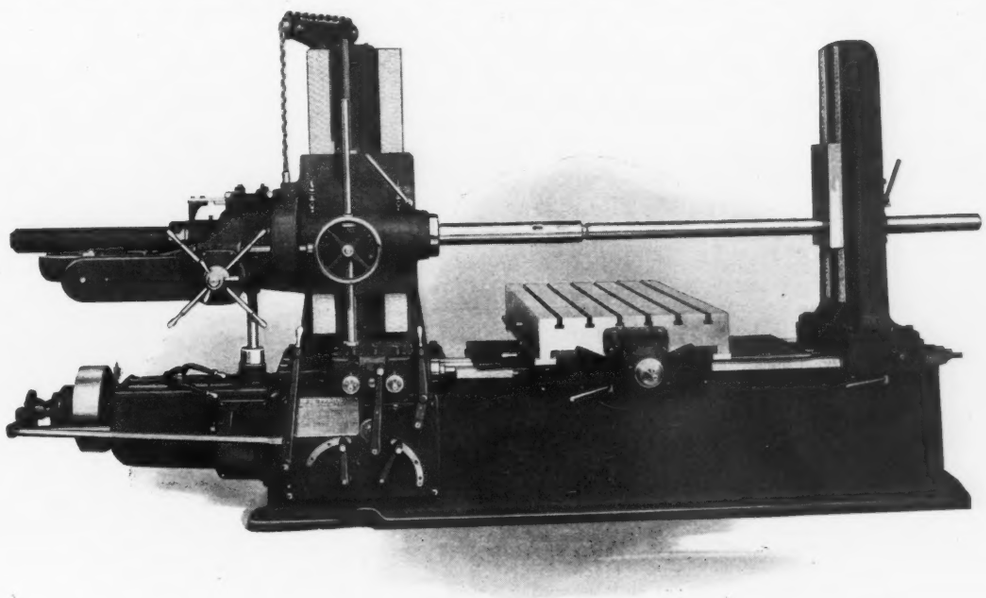
GOULD & EBERHARDT, Chancellor Ave., Newark, N. J. Booklet illustrating and describing the features of G & E high-duty shapers, designed especially with a view to rapidity of production.

W. S. ROCKWELL CO., 50 Church Street, New York City. Bulletin 258, listing applications of Rockwell air-tight blast gates, and reproducing letters of recommendation. Tables of dimensions are also included.

G. A. GRAY CO., Cincinnati, Ohio. Circular containing a description of the means provided for lubrication on Gray planers of the "Maximum Service" type, as well as instructions for oiling these machines.

KEYSTONE ROLLER BEARING CO., INC., 5011 Lancaster Ave., Philadelphia, Pa. Loose-leaf booklet containing tabulated data, including dimensions and prices, covering the line of roller bearings made by this concern.

SMITH'S INVENTIONS, INC., 2619 Fourth St., S. E., Minneapolis, Minn., manufacturer of welding and cutting equipment, is issuing a monthly publication known as "Smithograms," containing articles on welding practice, which is distributed without charge to those interested.



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CLEVELAND PUNCH & SHEAR WORKS, Cleveland, Ohio. Circular outlining the advantages of Cleveland machines and illustrating several of the different types, including multiple punch, bar shear, gate shear, plate planer, etc.

TRIUMPH ELECTRIC CO., Cincinnati, Ohio. Circular describing service tests made on the TR 25-horsepower self-starting motor by a customer, and containing a brief general description of the different types of Triumph motors.

O. B. HERLTH MFG. CO., INC., 272 Tolland St., East Hartford, Conn. Circular illustrating several applications of Herlth adjustable parallel gages for setting sine bars, height gages, and buttons, and gaging slots, snap gages, etc.

AMERICAN FLUID MOTORS CO., Philadelphia, Pa. Pamphlet entitled "The Simplified Application of High-pressure Hydraulic Power," describing the construction and operation of the Hele-Shaw high-pressure variable-stroke hydraulic pump.

BAIRD MACHINE CO., Bridgeport, Conn. Circular describing the straightening of wire on Baird roll wire straighteners. The pamphlet also illustrates the Baird six-spindle horizontal chucking machine, and gives specifications for this machine.

LEEDS & NORTHRUP CO., 4901 Stenton Ave., Philadelphia, Pa. Catalogue 87, illustrating and describing the potentiometer pyrometers made by this concern. Typical charts made from Leeds & Northrup single-point and two-point recorders are reproduced.

DWYER EQUIPMENT CO., 4534 W. North Ave., Chicago, Ill. Booklet entitled "Improved Heating for Industrial Buildings at Minimum Cost," describing the principles of industrial heating and showing a large number of installations of "Twinfan" unit heaters.

AVEY DRILLING MACHINE CO., Cincinnati, Ohio, is distributing a series of leaflets under the title of "Timely Topics," containing items of general news interest, as well as facts relating to Avey tool-room drilling machines and ball-bearing drilling machines.

CROUSE-HINDS CO., Syracuse, N. Y. Circular describing the features of the "vapor-proof" lantern made by this concern, which is intended for use wherever combustible vapor, gas, or dust is present. Bulletin 2059, giving data on condulets for concealing in concrete.

TIDE WATER OIL SALES CORPORATION, 11 Broadway, New York City. Pamphlet entitled "An Unusual History of Petroleum," containing an outline in twelve parts, of the origin, development, and uses of petroleum. Copies of this book may be obtained upon request.

CHASE METAL WORKS, Waterbury, Conn. Pamphlet containing directions on how to order brass, the purpose of the book being to point out what properties in brass are desirable for certain typical uses and to tell how to order such material so that the manufacturer will understand exactly what is wanted.

BARNES DRILL CO., INC., 814 Chestnut St., Rockford, Ill. Catalogue illustrating and describing the new Barnes automatic self-oiling all-geared drill and tapper. Booklet 6, illustrating different features of Barnes drilling and tapping machines, including the self-oiling system with which these machines are equipped.

DIAMANT TOOL & MFG. CO., INC., 95 Runyon St., Newark, N. J. Circular of standard punch and die sets for quantity and interchangeable production, outlining the advantages of using standardized sets and giving a table of dimensions of the different sizes. A handy checking list for die design is included.

EARLE GEAR & MACHINE CO., 4707-4715 Stenton Ave., Philadelphia, Pa. Circular entitled "Economy in Cold Sawing," containing illustrated descriptions and specifications of Lea Simplex cold cutting-off saws. Copies of this booklet will be sent upon request to anyone interested in cold sawing equipment.

GRATON & KNIGHT MFG. CO., Worcester, Mass. Folder illustrating and describing a new method of constructing leather belting, developed by this company, known as the "tight line construction of leather belting." The advantages of the new method over the old are clearly pointed out, and should be of interest to all users of belting.

CALORIZING CO., Pittsburg, Pa. Catalogue entitled "Heat-enduring Castings," dealing with the subject of alloys suitable for the production of castings exposed to temperatures as high as 2100 degrees F., with particular reference to Calite castings. Copies will be sent upon request to executives in industries where heat-enduring castings are in demand.

OHIO ELECTRIC & CONTROLLER CO., 5900 Maurice Ave., Cleveland, Ohio. Bulletin 204, illustrating and describing Ohio fractional-size alternating- and direct-current motors for application to pumps, machines, domestic appliances and other devices operated from lighting circuits. Bulletin illustrating numerous applications of Ohio fractional size ball-bearing motors.

WICACO SCREW & MACHINE WORKS, INC., Stenton Ave. and Louden St., Philadelphia, Pa. Circular descriptive of the Wicaco continuous oil groover, which is designed to cut different types of oil-grooves, including straight, cross and right- or left-hand helical grooves on internal and external surfaces; this machine may also be used for die-slotting and key-seating.

L. S. STARRETT CO., Athol, Mass. Catalogue 23, covering the complete line of tools made by this concern, consisting of 2200 precision tools, which include micrometers, steel rules, straightedges, measuring tapes, squares, protractors, gages, clamps, vises, wrenches, dividers, calipers, center-punches, screwdrivers, hacksaws, etc. Some of the tools are shown in this catalogue for the first time.

CHICAGO BELTING CO., 127 N. Green St., Chicago, Ill. Booklet containing a description of this company's pre-tested leather belting, which is made from leather that is carefully tested according to predetermined standards before the belt is made. Booklet containing instructions for making leather belts endless, together with a list and description of the tools and materials needed to do this work.

FARREL FOUNDRY & MACHINE CO., INC., Buffalo, N. Y. Pamphlet descriptive of Sykes generated double helical gears with continuous teeth, and Sykes gear generators. Pamphlet containing an article entitled "Interesting High-ratio Gear," descriptive of a one-tooth pinion, as well as an article describing the double helical gear-box for machine tools made by the Farrel Foundry & Machine Co.

KEYSTONE REAMER & TOOL CO., Millersburg, Pa., is distributing a Keystone reamer standardization chart showing the relative adaptability of several kinds and sizes of reamers for six common repair operations necessary in the overhaul of motors. The chart is prepared as a help to the buyer, to the stock clerk in arranging and labeling stock bins, and to the jobber's salesman in quickly identifying his customers' orders.

GLEASON WORKS, 1000 University Ave., Rochester, N. Y. Book containing data on the Gleason spiral bevel gear system, giving standardized tooth proportions for generated spiral bevel gears, which were adopted in October, 1922, by the American Gear Manufacturers' Association as the recommended standard for future design. The book was distributed first at the convention of the American Gear Manufacturers' Association held in Buffalo in April of this year.

GARDNER MACHINE CO., 414 E. Gardner St., Beloit, Wis. Circular containing illustrations and detailed descriptions of the Gardner line of ball-bearing polishing lathes, which are made in both belt- and motor-driven styles. Bulletin describing the features of construction of the Gardner No. 27 double-spindle disk grinder which is designed to handle parts having two opposite parallel sides of approximately equal area, such as coil springs, wrenches, gear blanks, etc., at a high rate of production.

RAMSEY CHAIN CO., INC., 1039 Broadway, Albany, N. Y., has issued a text-book on power transmission, and silent chain transmission in particular, treating of various drives—leather and rubber belting, gearing, direct drives and silent chains. The book discusses transmission problems in textile machines, machine tools, punch presses, shears, woodworking machinery, fans and blowers, mixing machinery, pumps and compressors, steel plants, etc. It includes engineering information for laying out silent chain drives.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912

of MACHINERY, published monthly at New York, N. Y., for April 1, 1924.

State of New York } ss.
County of New York }

Before me, a Notary Public, in and for the state and county aforesaid, personally appeared Matthew J. O'Neill, who, having been duly sworn according to law, deposes and says that he is the treasurer and general manager of the Industrial Press, Publishers of MACHINERY, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Industrial Press, 140-148 Lafayette St., New York; Editor, Erik Oberg, 140-148 Lafayette St., New York; Managing Editor, None; Business Managers, Alexander Luchars, President, 140-148 Lafayette St., New York, and Matthew J. O'Neill, Treasurer and General Manager, 140-148 Lafayette St., New York.

2. That the owners of 1 per cent or more of the total amount of stock are: The Industrial Press; Alexander Luchars; Alexander Luchars, Trustee for Helen L. Ketchum, Elizabeth Y. Urban, and Robert B. Luchars; Matthew J. O'Neill; Louis Pelletier; and Erik Oberg. The address of all the foregoing is 140-148 Lafayette St., New York.

3. That there are no bondholders, mortgagees, or other security holders.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

MATTHEW J. O'NEILL, General Manager.

Sworn to and subscribed before me this 18th day of March, 1924.

(SEAL)

CHARLES P. ABEL,
Notary Public, Kings County No. 187
Kings Register No. 5052
New York County No. 125 New York Register No. 5134
(My commission expires March 30, 1925.)